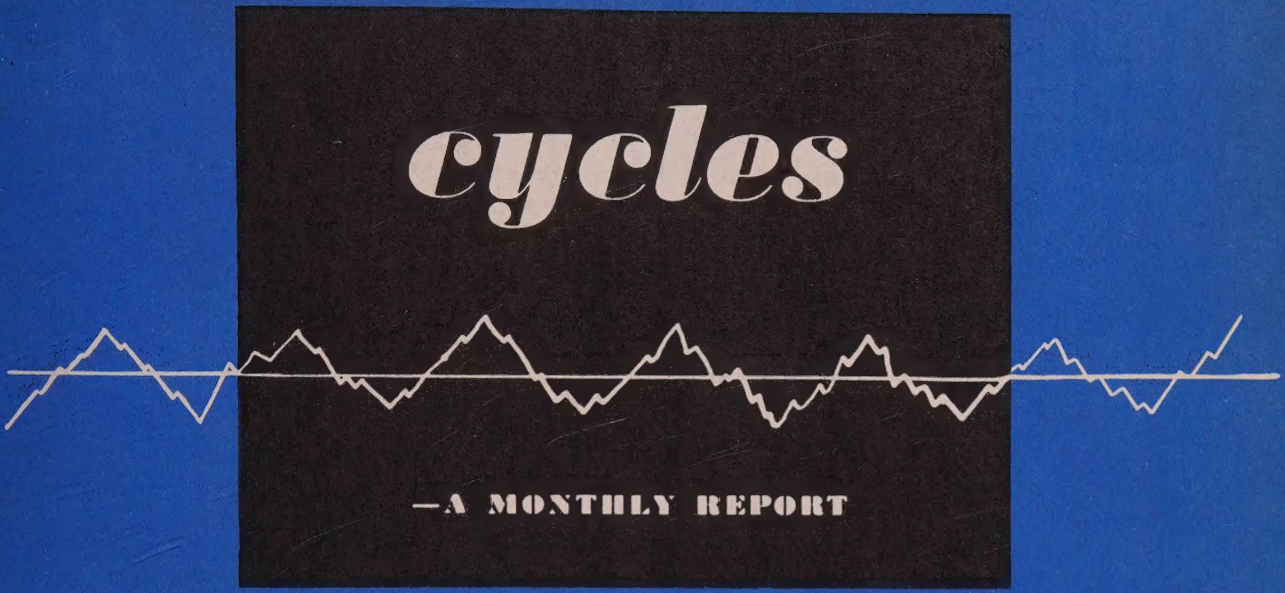

cycles

—A MONTHLY REPORT

May 1954

FOUNDATION FOR THE STUDY OF CYCLES
New York, New York

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cycles
-a monthly report

The official Bulletin of the Foundation for the Study of Cycles

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The Director's Letter

Dear Member:

Last November, when I happened to mention to the Editor of the New York Times Magazine that I did not think the coming depression would be a *major* one, he found my ideas so different from the then prevailing belief that he asked me to write an article to outline them.

I never found time to write the article he wanted, but I did sit down immediately to write to you. As you may remember I started the letter I wrote you at that time, "The coming depression will be a minor one, as best I am able to say at the present time. I look forward to no *major* depression until the late 1960's or 1970's."

I see no reason to change this opinion, but as I write this letter (March 30, 1954) I find myself again out of step with majority opinion. Current ideas seem to be that the "depression" is over!

It never bothers me when my opinion runs counter to that of other people. What really bothers me is when I find myself in agreement with others. Then I am always afraid that I am wrong.

How It Came Out

In the How It Came Out Department of this report I am including a few more examples to show you how the six year cycle in the sales and/or production of various industrial companies has worked out since this cycle in these particular figures was discovered in 1949.

Do not think of the work of 1949 as *forecasts* of the sales of these companies. To make forecasts you have to take a number of cycles into account. The work of 1949 was undertaken merely to show the widespread occurrence of the 6-year cycle. It is being brought up to date so that you can see the extent to which this particular cycle is continuing. If a cycle continues you can feel more confident that the cycle was not present merely by accident.

A Warning

Speaking of cycles present by accident reminds me to warn you against leaning too heavily on cycle forecasts made on the basis of an insufficient number of repetitions of the cycle, whether made by me or anyone else. Just because Amalgamated Kumquat Preferred has gone up and down a few times in a 16-week cycle, let us say, does not mean that it will continue in this pattern. Unless there are *many* repetitions of a cycle, the observed regularity may have come about as the result of random forces.

The Foundation has brought some knowledge of cycles to many people. There are those who seek to capitalize on this fact. Some of these persons, though doubtless well intentioned, are not very competent. Again I say, beware!

Your Picture—and Mine

The other day I noticed my picture in the New York Times. You were there, too! I was much pleased. I am reproducing the picture for you on page 171 of this report.

First of all, in the center of the page is a picture of the sun. Then in the lower left hand corner, to scale, is a picture of the earth. Finally, on the earth, in the middle, at about 40° N. Latitude, are you and I. It is a little hard to see us, for we are pretty small, but we are there all right. And *very* important.

Polishing the Tin Cup

At this point I wish to polish up our tin cup so that it will look attractive to you. Perhaps, if it does, you will drop a thousand dollars or so into it so that the remarkable findings of Dr. Leonard W. Wing, discussed in the lead article of this issue, can be extended. Thank you very much!

Figures Wanted

If you have available any long series of figures send them in to research headquarters. If they show evidence of cycles and if I think they would be of general interest, I will publish articles about them similar to the articles printed in this issue regarding Sears Roebuck & Company, the Goodyear Tire & Rubber Company, etc.

Publication Office Moved

Our publication office in New York City is now at 680 West End Avenue, New York 25, New York. The new building is on the north east corner of West End Avenue and 93rd Street.

The building where we were previously located was sold. The new tenant wished occupancy. There was nothing we could do but move.

Cordially yours,

Edward R. Dewey

Director

Research

DR. WING'S LATEST CYCLE DISCOVERIES

Summary

This article is a pre-publication account of some important observations recently made by Dr. Leonard W. Wing.

In brief, Dr. Wing has observed that the times of the peaks of a certain 4 1/4-year temperature cycle come later (in a regular sequence) as you find these peaks in various latitudes from pole to equator. The pattern found by this behavior is similar to the butterfly pattern characteristic of sunspots. The same 4 1/4-year cycle in other phenomena seems to behave the same way, too.

If the patterns observed by Dr. Wing prove to have significance, he has made what may be one of the really great discoveries in respect to cycles.

IN this article I wish to tell you of some astonishing observations in respect to cycles which have recently been made by Dr. Leonard W. Wing, a Research Associate of the Foundation for the Study of Cycles. In this work Dr. Wing has had the active cooperation of the Institute of Human Biology at the University of Michigan.

Four Observations

Dr. Wing has observed four things:

First, he finds that the calendar timing (dates) of the highs (and lows) of a certain weather cycle (a temperature cycle 4.222 years in length) come progressively later as you find them from either polar region to the equator.

Second, he finds that, for any given latitude, the calendar timing (dates) of highs (and lows) of this cycle tend to be identical in the Northern and in the Southern Hemispheres.

Third, he finds that the length of time required to slip from pole to equator is about 0.71 times the length of the cycle.

Fourth, he finds, as far as he has been able to progress in the work, that cycles of other lengths seem to behave the same way.

Weather Records at 100 Places

Dr. Wing's observations are based upon a study of temperature at nearly one hundred different locations all over the globe from Spitzbergen in the Arctic to Laurie Island in the South Orkneys. They cover Europe, Africa, Asia, Australia, and North and South America. A list of the localities will be given at the end of this article.

In spite of the vast amount of work done by Dr. Wing and the extensiveness of his observations, it must be remembered that there are hundreds of other places on the globe where temperature records have not yet been investigated, and that there are dozens of other cycles that need also to be studied before one can say that the law of geographical distribution has been discovered. Nevertheless, Dr. Wing's work has progressed far enough to enable him to formulate a hypothesis of behavior. This hypothesis (that temperature behaves as indicated above) is now in shape to be tested and confirmed, or found wanting.

Dr. Wing's observations are *potentially* one of the greatest advances in cycle study since the study of cycles was inaugurated about 250 years ago. *Potentially* it may be one of the great advances in meteorology also.

The Behind-the-Scene Story

I think you might like to have, in advance of publication, a behind-the-scenes account of how Dr. Wing happened to make his discoveries, and to learn a little more about them.

Starts with the Pine Grosbeak

It all started with a study of the flight years or periodic invasions of the Pine Grosbeak. As you may know, the Pine Grosbeak is a Northern bird seen only at intervals in the United States. However, every four years or so, for some reason as yet unknown, Pine Grosbeaks appear in the Lake States and other northern areas of the United States. These flight years, as they are called, have been recorded at about four year intervals from 1870 right up to the present time.

Although these invasions tend to recur at about four-year intervals, from time to time something breaks the sequence and the pattern of flight years gets out of step with itself. For example, after invasions in 1870, 1874 (4 years later), and 1878 (4 years after that) there was an invasion in 1880 after an interval of only two years. The cycle had reversed. The four year cycle then resumed with 1880 as a base. After a while the cycle reversed another time.

Reversing cycles are quite common. They can be accidental or they can be the result of two other cycles, one slightly longer and one slightly shorter than the observed behavior. In studying the invasion patterns, Dr. Wing calculated (by means of a time chart) that the behavior observed could have been the result of two cycles: mathematically one would be 3.694 years (44.3 months) long, the other 4.221 years (50.7 months) long. There is no assurance that the behavior *is* the result of cyclic forces of these lengths, but it *could* be. The result observed is what we would get *if there were* forces of these lengths operating simultaneously.

What could be the cause of this peculiar behavior? Is it something within the Pine Grosbeaks that makes them behave this way, or do they come south in response to some environmental influence? If the influence is environmental, what could it be?

Cycles Help to Solve Mystery

Here is where cycles can help us. If we can find an environmental factor that fluctuates in a cycle which is identical in length with the cycle of the Pine Grosbeak we may have a clue.

I am told that engineers use this method to trace vibrations through the body of an airplane. They get the wave length of a particular vibration. They then trace its cause by finding what else within the airplane has vibrations of the same wave length.

There are many environmental factors that could be tested to see if they fluctuate with the same wave lengths as the Pine Grosbeak. For example temperature, humidity, barometric pressure, rainfall, variations in ozone content, variations in terrestrial magnetism, or per cent of sunshine.

Dr. Wing Studies Temperature

In trying to run down environmental factors that might have the same cycle as the Pine Grosbeak, Dr. Wing decided to investigate temperature. As the Pine Grosbeak is a northern—almost an Arctic—bird, Dr. Wing began to study the cycles in the thawing (and freezing) dates of various northern rivers.

Thawing Dates of Arctic Rivers

It is pretty obvious that a warm winter and a warm spring will result in an early thaw; a cold winter and a cold spring will result in a late thaw. As the dates when the ice in the rivers break up has been carefully recorded over many years it is possible, through a study of such dates, to get light on the probable changes in the temperatures of the areas involved. By this method you can make the calendar serve as a themometer.

When Dr. Wing studied these freezing and thawing dates he found evidence of a cycle about 4 1/4 years in length. You will remember that this is one of the two cycles seemingly present in the behavior of the Pine Grosbeak.

Dr. Wing does not like the word " about. Like any good scientist he wants to know *exactly*. Of course, no one can ever know *anything* exactly, but one can know as exactly as one can! To get cycle lengths with more precision one needs to use long series of figures. Data on the freezing and thawing of northern rivers were available to Dr. Wing for only 40- or 50-year periods (see his article, "Cyclic Trends in Arctic Seasons" in the Autumn 1951 *Journal of Cycle Research*), so Dr. Wing turned to measurements of glacial varves, one series of which in the North Country was available over some 570 consecutive years.

Thickness and Thinness of Glacial Varves

Varves are thin layers of mud laid down year by year. The nature of the material deposited in the winter differs from the material deposited in the summer, so that the varve laid down one year can be distinguished from the varve laid down in the year following.

Some varves are thick, others are thin, These differences have been studied under microscopes and have been measured with great accuracy.

Varves are usually found in old lake bottoms, many of them in lakes fed by melting glaciers. It stands to reason that in a warm year, when the glaciers melted more, the amount of deposit washed down by the glacier water would be more—and the varve thicker—than in the cool years when the glacier melted less. If this is so, the thickness of the varve should be a rough measure of temperature. Any regularity discovered in the alternate thickness and thinness in the varves would therefore presumptively be a measure of weather cycles.

The situation is not quite as simple as I have made it appear. Rainfall is an important element in varve thickness, too. Lots of water rushing down may carry more or larger particles and may thus make varves thicker. Nevertheless, I think it would be generally agreed that temperature is a factor in the thickness and thinness of glacial varves.

The varves to the study of which Dr. Wing now addressed himself were laid down something over 10,000 years ago.

A cycle study of these varves did in truth show a cycle about 4 1/4 years in length in the 570 years of data available. During this time the cycle had a chance to repeat 135 times. This number of repetitions was enough to enable Dr. Wing to determine that the length of this cycle in the glacial varves was 4.222 (± .004) years in length--this is the length originally estimated for our old friend the Pine Grosbeak with which all of this started. This measurement of 4.222 is more exact than the length of about 4 1/4 as found in the break-up of northern rivers. It brought a corresponding degree of joy to Dr. Wing's scientific heart.

Thickness and Thinness of Tree Rings

"Now," said Dr. Wing, "if only I had another series of figures longer yet, I could get the length still more accurately." And, of course, he was right. The 570 year record was the longest consecutive series of glacial varve widths we could furnish him. So, perforce, he turned to tree ring widths which also may be a measure of temperature.

Tree rings have the added advantage that, if you know the year when the tree was cut down, you can compute the actual calendar date of each ring. This fact enables you to know the *timing* of the cycle as well as its length.

As I am sure you know, trees grow by adding a layer of wood to their circumference each calendar year. The part of the layer that is added during the winter is dense and firm. The part added during the summer is softer. These two parts of the annual ring, the hard and the soft, constitute the layer for the given calendar year. Some of these layers are wide, and some are narrow. There is a tendency for wide layers to come at uniform time intervals—cycles.

Tree ring widths are usually available over a long period of time. Some of the sequoia tree ring widths go back two or three thousand years, but Dr. Wing used some Arizona tree ring records which we published in our report for May 1951. Taking the last 1,043 years of these records he again discovered a cycle of about 4 1/4 years long which, in this case, also measured out to 4.222 (± .002) years in length.

When I said that Dr. Wing discovered a cycle of this length in these tree ring figures and these varve figures I do not mean to imply that every 4 1/4 years like

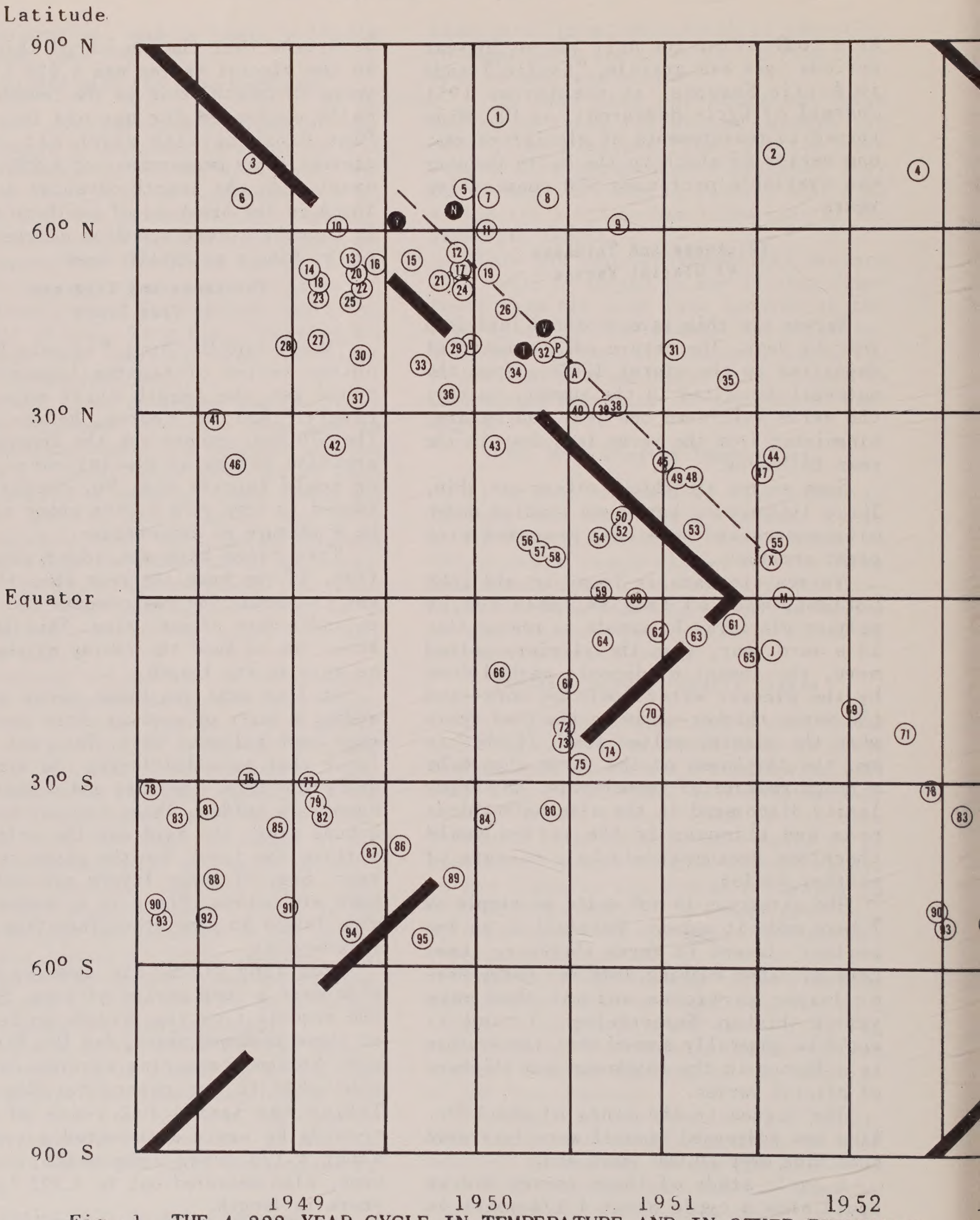
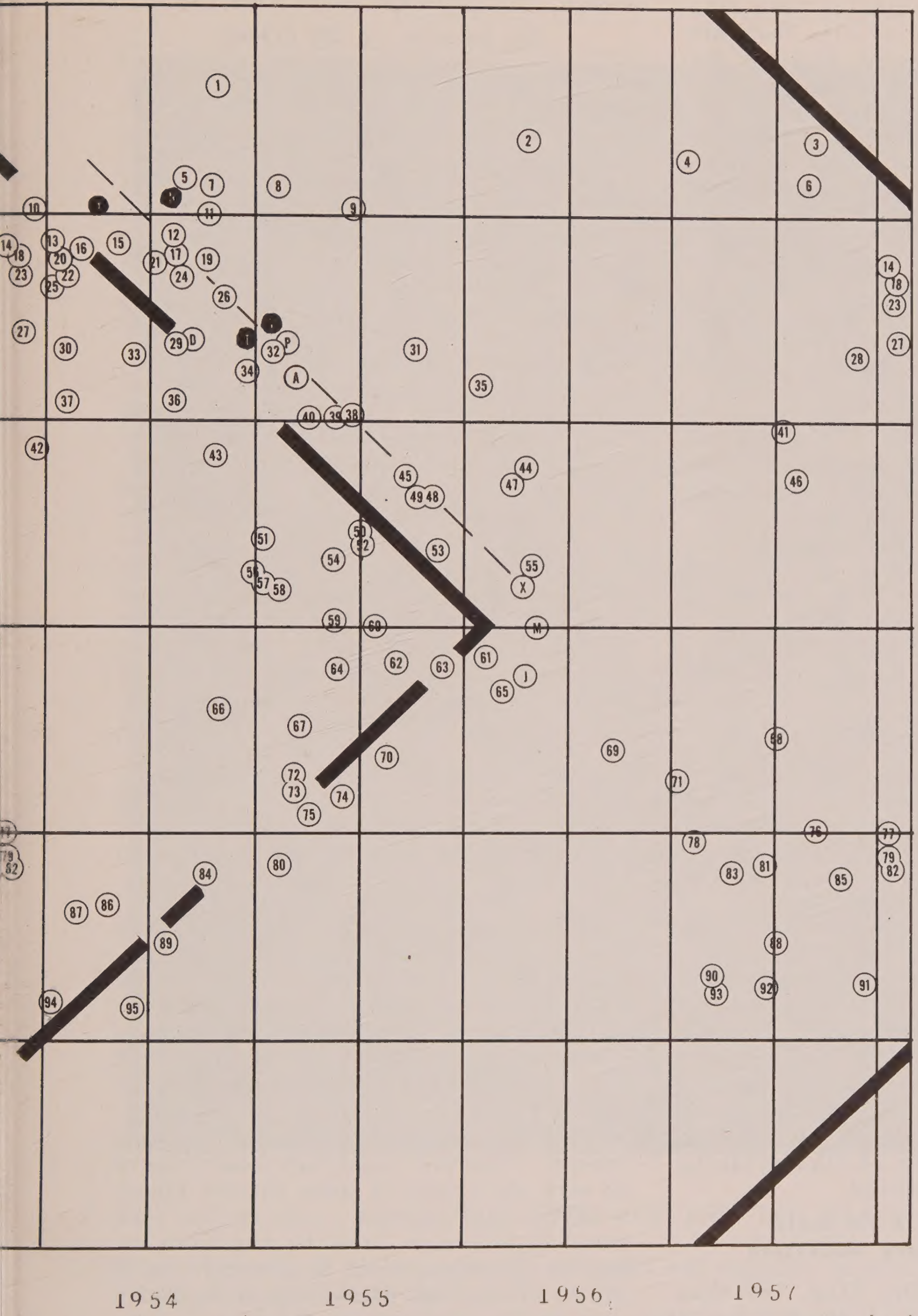


Fig. 1. THE 4.222-YEAR CYCLE IN TEMPERATURE AND IN OTHER PHENOMENA PLOTTED BY LATITUDE

The horizontal scale represents time. The vertical scale represents latitude. The numbered circles mark lows of the typical 4.222-year cycle in temperature as indicated by the key at the end of this article. Lettered circles are epochs of other phenomena; open circles are lows, solid circles are highs as in the key. These epochs all fall in the temperature band.



The "epoch" is the beginning of a cycle. In the temperature cycles it is taken as the typical time of trough. In the other phenomena it is crest or trough as indicated in the key.

Note that in both hemispheres the temperature lows come later as the phenomena are found nearer the equator in a mirror image or "butterfly" pattern indicated by the heavy diagonal lines. The dashed line indicates the latitudinal slippage of the tree ring epochs. It seems unlikely that a latitudinal shift as definite as this could come about by chance.

clockwork the varve widths or tree ring widths were thicker. Not at all. There are many other cycles present in both the varves and the tree rings as well as various random factors with the result that you can see the 4.222-year cycle in these figures only by averaging a great number of consecutive cycles so that the other cycles and accidental factors are "washed out." Instead of saying that a cycle of this length is present in these figures it would probably be better to say that *on the average* a cycle of this length is present in each of these series, and, in fact, in each half of each of these series.

Length 4.222 Years

By now, Dr. Wing was pretty well satisfied that the length of this particular cycle was 4.222 years. He was therefore ready to investigate the actual weather records which for the most part are not available for more than 50 or 100 years. Knowing the exact length of the cycle makes an investigation easy. ("Easy" may sound easy, but it is laborious none the less.)

Canadian Temperature Records

First of all, because the Pine Grosbeak is a Northern bird, he studied the weather records of Dawson in the Yukon and Edmonton in Alberta. The 4.222-year cycle in the temperature records in these places was not at first visable. It was obscured by cycles of other lengths. After the cycles of these other lengths had been isolated and removed, however, the 4.222-year cycle remained clearly present in each half of the figures for each place.

Dr. Wing then went on to find the same cycle in some other temperature records, those of Chicago, for example, and one or two other places in North America. He found at least a trace of this cycle in every place he investigated.

Also Present in Old World and in the Southern Hemisphere

"I wonder," said Dr. Wing, "if this cycle is also present in the Old World and in the Southern Hemisphere." With this thought in mind he investigated records of Argentina and Europe. Sure enough, the cycle was there also!

The Behavior in 100 Places

"Let us now do this thing wholesale," said Dr. Wing. "Let us get records all around the World: Europe, Asia, Africa, and Australia, as well as North and South America. Let us investigate this cycle in a hundred different places and see if it is universal." No sooner said than attempted; but it was a long time after it was attempted before it was done.

When the work was completed, Dr. Wing had evidence of a 4.222-year cycle in all these different places. But the evidence for some places was much clearer than the evidence for other places because, doing the job wholesale, it proved impossible to do the detailed work necessary to carve away the conflicting cycles one by one, as he had done with his preliminary work, so that the 4.222-year cycle might remain as a residue. When the series of figures was short, as it often had to be to get geographical distribution, it was impossible to know the length of the 4 1/4-year cycle with any accuracy, and it had to be assumed that any cycle of this general order of magnitude was 4.222 years as it had proved to be in the longer series of figures. However, whether or not there really are 4.222-year cycles present at all of these places has nothing to do with the important part of the story to come in a moment.

Peaks Scattered

When he had before him the results of his labors in respect to the hundred different localities (it finally turned out to be 95) Dr. Wing found himself wondering whether or not the highs of the various cycles came at the same time. They did not. They were scattered over the calendar like the stars of the heaven.

Dr. Wing then wondered whether, as with sunrise, longitude might have something to do with the timing of these various highs, —if the high of this cycle in New York came at the same time as the high in Bogota, Columbia, which is directly south of it; if the high of this cycle in Berlin came at the same time as the high in Rome or in Capetown, South Africa, all three of which places fall on the same north and south line. This investigation led him

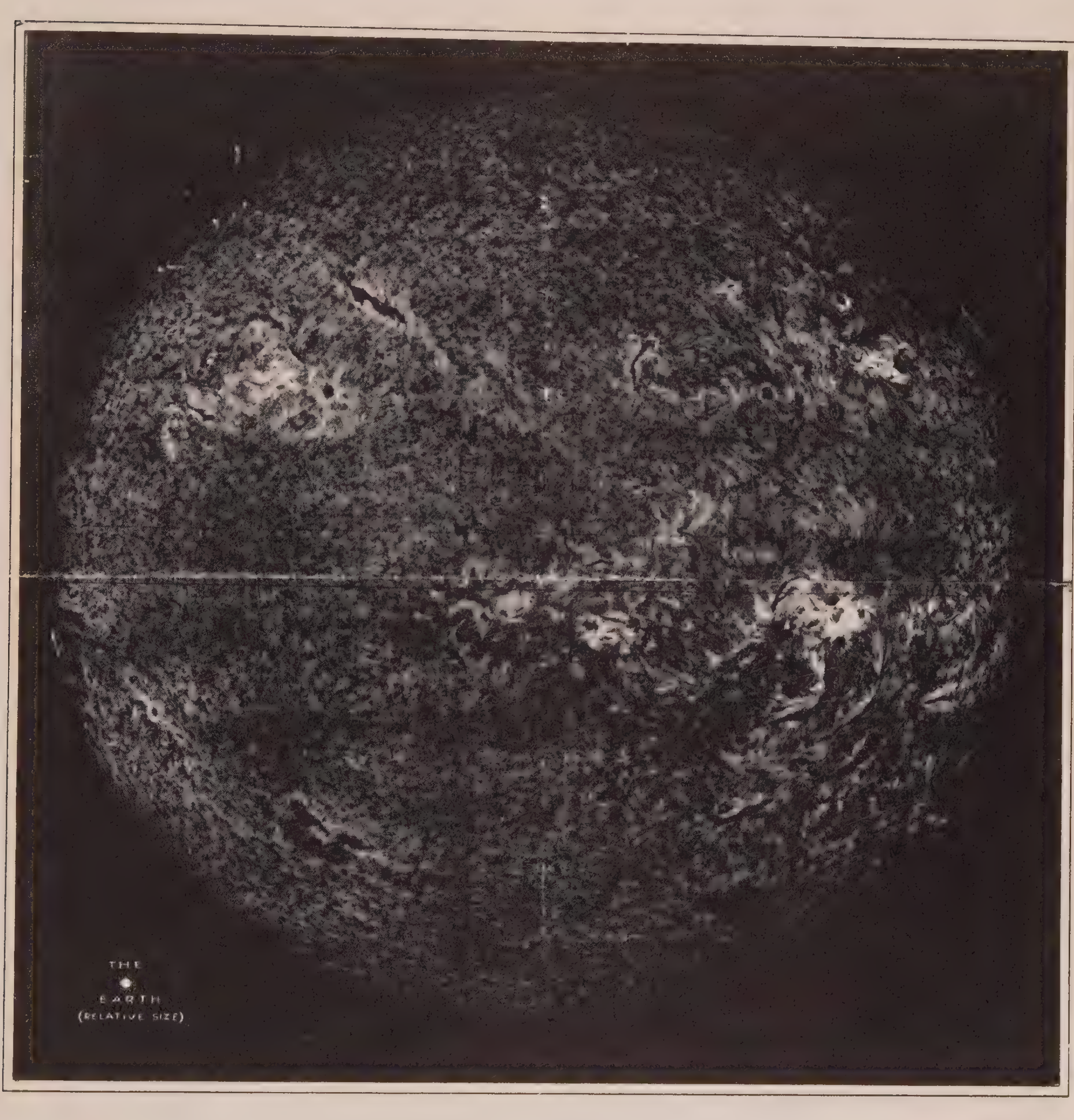


Fig. 2. THE SUN AND THE EARTH

A picture of the sun showing sun spots and showing, in the lower left hand corner, the earth reproduced to scale.

In a model of the solar system where the sun, like the photograph, is reduced in size to a ball six inches in diameter, the earth, a pellet about 1/16 of an inch in diameter, would be situated about fifty feet away.

Reprinted from the New York Times

nowhere.

Pattern Emerges When Peaks Arranged by Latitude

Then Dr. Wing found himself wondering if latitude might have something to do with it. That is, if all the northern places might have one timing, the middle latitudes another timing, and the equatorial latitudes still another. Here at last pattern emerged as you can see by reference to Fig. 1. The highs did come progressively later and later as you go from the polar latitudes toward the equator, not only in the Northern Hemisphere but in the Southern Hemisphere also. The slippage amounts to about 4 months for every 10° of latitude. This fact suggests that if the behavior starts at the pole it takes about 3/4 cycle lengths (0.707 to be exact) for the highs to traverse the whole hemisphere If we do this the other way and measure the slippage first (4 months for 10°), the cycle is about 1½ times the slippage (1.41 to be exact).

Tree Rings Fit the Pattern

Dr. Wing, having a restless and inquiring mind, now wondered if his Arizona tree rings fitted into the pattern. They did, as shown by the circle lettered A.

How about other tree rings. Tree ring records other than in Western United States are hard to find. Dr. Wing investigated the 4.222-year cycle in 170 years of tree rings in the Yukon, 148 years of tree rings in Alaska, 391 years of tree rings in Vermont, 237 years of tree rings in Pennsylvania, and 416 years of tree rings in Java. They all fitted into the pattern as indicated by the circles lettered Y, N, V, P, J, respectively, only sometimes it was the *wide* tree rings that fell into place, sometimes the *narrow*, without any apparent rhyme or reason.

Deaths Fit the Pattern

Dr. Wing then investigated the 4.222-year cycle in deaths in Massachusetts first from all causes, and second from tuberculosis. He found that these figures also fitted into the pattern, only, like tree rings, in different phase relationships. Lows of deaths from all causes (D) corresponded to the lows of temperature, highs of deaths from tuberculosis (T) corresponded to the lows of temperature. Dr. Wing has not yet had time to investigate other mortality data or other phenomena such as crop yields for which figures on a geographical basis are available for widely distributed geographical areas. But he did find a long record of terrestrial magnetism as shown by the circle lettered M.

Other Cycles Seem to Behave the Same Way

Do other cycles behave the same way? It is not yet known, but preliminary investigation of the closely related 4.418-year (53-month) cycle and the 9.6-year cycle suggest that they too slip across the hemisphere in about 0.707 cycle lengths with highs (and, of course, intervening lows) coming about 0.08 cycle lengths later (0.707 ÷ 9) for each 10° of latitude.

Sunspot Behavior

If you are at all acquainted with the behavior of sunspots, it will immediately occur to you that they also behave in much the same way. At the beginning of a sunspot cycle the spots occur at about 40° North and 40° South Latitude. As the cycle progresses the spots seem to slip equatorward and appear progressively at 30°, 20°, 10°, finally vanishing at the equator about 11 years after the beginning of the cycle. The actual behavior for two cycles of sunspots is diagrammed in Fig. 2 below.

Sunspots generally come in pairs of opposite magnetism. In the northern solar hemisphere, in one cycle, spots of northern polarity will lead, spots of southern polarity will follow. In the southern hemisphere, in the same cycle, south polarity spots will lead and north polarity spots will follow.

In the next cycle the situation is reversed. South polarity spots will lead in the northern hemisphere, north polarity spots will lead in the southern hemisphere. The reason for this alternation is not yet known, but a result of it, or at least a concurrent behavior, is that at these periods of reversal, or neutralization if you like, there are few or no spots. Dr. Wing has noticed that if you

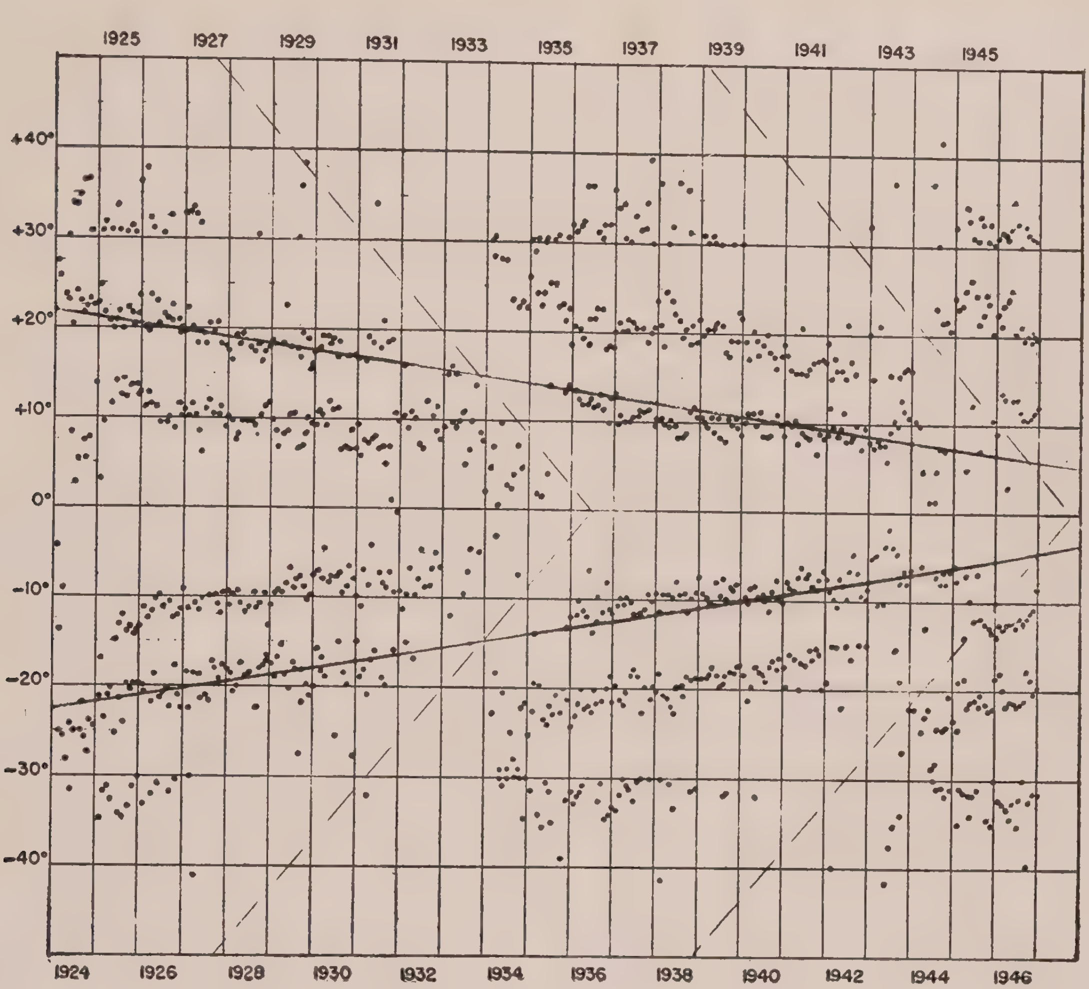


Fig. 3. LOCATIONS OF SUNSPOTS BY ZONES SHOWS DRIFT OF LATITUDE WITH THE PROGRESS OF THE SOLAR CYCLE

To the basic chart above, reproduced from *Sunspots in Action* by Dr. Harlan True Stetson (The Ronald Press Company, 1947) I have added broken diagonal lines to show that the zones where there are few or no spots slip across the face of the sun about 1¾ years every 10°. Starting at the equator these diagonal lines would reach the poles in 15 or 16 years.

Note also that some of the spots seem to fall in bands which, if extended, would reach the poles in perhaps 120 years.

Other patterns can be traced.

diagram this zone of neutralization as in Fig. 2 it also slips across the face of the sun at a rate of about 1 3/4 years for 10° or 15 3/4 for 90°. When multiplied by 1.41, we get 22.2, the length of the sunspot cycle (alternate cycles reversed)! Whether this coincidence has any significance is of course not yet known, but it is highly provocative. Dr. Wing puts out the additional postulate that the bands of spots and absence of spots in each part of the sunspot chart (Fig. 3) are actually equatorward shifts of long cycles and appear successively closer to the equator.

The Work Only Begun

I do not want to make too much of these observations of Dr. Wing. He would be the last person in the world to suggest that the investigation is finished. First, we do not know that there is a 4.222-year cycle in all these different weather records. We merely know that *if* there is a cycle of this length in these figures, its time, as nearly as we have so far been able to determine it, falls into the pattern indicated above. It is presumed that the variations from a perfect pattern are caused by the presence of random factors and other cycles close to 4.222 years in length which pull the apparent time of the 4.222-year cycle one way or the other. But this, of course, is not yet known either. What *is* known is that when you treat figures of all these different temperature records the same way the results do fall into an unmistakable geographical pattern, that other phenomena fall into the same pattern, that other cycles seem to fall into patterns of the same sort, and that the patterns bear a striking resemblence to sunspot behavior patterns.

Dr. Wing has investigated temperature at about a hundred different places throughout the earth, which he obtained from "World Weather Records," published by the Smithsonian Institution. Two hundred more places remain to be investigated. He has investigated one cycle. Many more cycles remain to be investigated. Many more phenomena remain to be investigated too.

Now that we know where we want to go it would be rather easy to prepare IBM punch cards for all the temperature records of the World Weather Records to see whether or not the 200 other stations behave the same way. The punch cards could then be arranged by other cycle lengths to see whether or not other cycles behave the same way also. The cost would be moderate, but unfortunately even a modest amount of money is not available for this purpose at the present time, so I am afraid the confirmation or refutation of Dr. Wing's hypothesis will have to remain in the realm of the unknown for the present.

Conclusions

Where you have pattern you generally have significance, for random occurances do not usually fall into pattern. By discovering pattern in the distribution of cycle highs (and of course in the cycle lows which fall between) Dr. Wing has shown us that this behavior is almost certainly not random.

As the behavior is seen to have something to do with latitude, and as latitude has to do with the poles we may conclude that either the spinning of the earth or the magnetic polarity of the earth may have something to do with cycles. This is a great step forward.

Enough facts are now available to set up a hypothesis. The next step is to test this hypothesis in every possible way to make sure that it is the true explanation of the way cycles behave.

If the hypothesis stands up, Dr. Wing will have made probably the greatest single contribution to the study of weather cycles since they were first discovered two or three hundred years ago. *E.R.D.*

Pine Grosbeak

TABLE 1.

LEGEND FOR NUMBERED CIRCLES IN FIG. I

Temperature

Serial Number	Place	Latitude ° '	Years of Record
1	Spitzbergen	78 2 N	1912-1936
2	Upernivik, Greenland	72 47 N	1875-1936
3	Gjessvar-Mehavn, Norway	71 6 N	1878-1940
4	Jacobshavn, Greenland	69 13 N	1874-1940
5	Stykkisholm, Iceland	65 5 N	1846-1940
6	Archangel, Russia	64 35 N	1881-1940
7	Nome, Alaska	64 30 N	1907-1940
8	Dawson, Yukon Territory	64 3 N	1902-1940
9	Ivigtut, Greenland	61 12 N	1880-1940
10	Bergen, Norway	60 24 N	1816-1940
11	Helsinki, Finland	60 10 N	1829-1940
12	Swerdlowsk , Russia	56 50 N	1881-1940
13	Tomsk, Siberia	56 30 N	1881-1940
14	Edinburgh, British Isles	55 55 N	1764-1940*
15	Moscow, Russia	55 50 N	1881-1940
16	Copenhagen, Denmark	55 41 N	1768-1940
17	Omsk, Siberia	54 58 N	1888-1940
18	Vilno, Poland	54 4 N	1781-1937
19	Edmonton, Alberta	53 33 N	1883-1940
20	Nikolaywsk-on-Amur, Siberia	53 8 N	1881-1940
21	Barkerville, Canada	53 2 N	1888-1940
22	Berlin, Germany	52 27 N	1869-1938
23	Irkutsk, Siberia	52 16 N	1882-1940
24	Greenwich, British Isles	51 28 N	1841-1940
25	Nerchinsky, Siberia	51 19 N	1881-1940
26	Vienna, Austria	48 15 N	1775-1940
27	Alma Ata, Siberia	43 16 N	1881-1940
28	Detroit, Michigan	42 20 N	1840-1940
29	Chicago, Illinois	41 53 N	1873-1940
30	Cheyenne, Wyoming	41 81 N	1873-1940
31	New Haven, Connecticut	41 18 N	1781-1940
32	New York, New York	40 43 N	1822-1940
33	Krasnovodsk, Siberia	40 0 N	1883-1940
34	Nashville, Tennessee	36 10 N	1873-1940
35	Tokyo, Japan	35 41 N	1876-1935
36	Charlestown, South Carolina	32 47 N	1823-1940**
37	San Diego, California	32 43 N	1850-1940
38	Alexandria, Egypt	31 12 N	1870-1940
39	Mobile, Alabama	30 41 N	1873-1940
40	Abassia, Egypt	30 5 N	1869-1940
41	Bushire, Persia	29 00 N	1878-1940
42	Jask, Persia	25 45 N	1893-1940
43	Allahabad, Egypt	25 26 N	1876-1940
44	Havana, Cuba	23 8 N	1871-1940
45	Hongkong, China	22 18 N	1884-1940
46	Honolulu, Hawaii	21 19 N	1883-1940
47	Akyab, Burma	20 7 N	1878-1940
48	Mexico City, Mexico	19 26 N	1878-1939
49	Bombay, India	18 55 N	1878-1940
50	Madras, India	13 4 N	1875-1940
51	Bangalore, India	12 58 N	1875-1940
52	Aden, Arabia	12 46 N	1881-1930
53	Port Blair, India	11 41 N	1867-1940
54	Trinidad, B.W.I.	10 40 N	1863-1940
55	Colon, Canal Zone	9 21 N	1908-1940
56	Trincomalee, Ceylon	8 34 N	1870-1940
57	Georgetown, British Guiana	6 50 N	1887-1940
58	Sandahan, Borneo	5 50 N	1905-1939***
59	Singapore	1 17 N	1911-1939
60	Entebbe, Unganda	0 5 N	1902-1931
61	Seychelles Island	4 37 S	1895-1940
62	Quixeramobim, Brazil	5 12 S	1896-1940
63	Zanzibar, East Africa	6 10 S	1892-1940
64	Batavia, Java	6 11 S	1866-1940
65	Port Moresby, New Guinea	9 29 S	1903-1940
66	Darwin, Australia	12 28 S	1882-1940
67	Apia, Samoa	13 48 S	1890-1940
68	St. Helena	15 57 S	1893-1940
69	Salisbury, Rhodesia	17 48 S	1898-1940
70	Antananarivo, Madagascar	18 55 S	1889-1939
71	Bulawago, Rhodesia	22 13 S	1898-1940
72	Rio de Janeiro, Brazil	22 54 S	1871-1940
73	Sao Paulo, Brazil	22 34 S	1887-1940#
74	Salta, Argentina	24 47 S	1901-1940
75	Brisbane, Australia	27 28 S	1887-1940
76	Goya, Argentina	29 9 S	1877-1938
77	Durban, South Africa	29 51 S	1885-1940
78	Cordoba, Argentina	31 25 S	1873-1940
79	Santiago, Chile	33 27 S	1861-1940
80	Sydney, Australia	33 52 S	1859-1940
81	Capetwon, South Africa	33 56 S	1857-1940
82	Buenos Aires, Argentina	34 35 S	1856-1940
83	Montevideo, Uruguay	34 48 S	1883-1930
84	Adelaide, Australia	34 56 S	1857-1940
85	Aukland, New Zealand	35 50 S	1864-1940
86	Punta Galera, Chile	40 1 S	1899-1940
87	Wellington, New Zealand	41 16 S	1864-1940
88	Sarmiento, Argentina	45 30 S	1904-1940
89	Dunedin, New Zealand	45 52 S	1864-1940
90	Santa Cruz, Argentina	50 11 S	1901-1940
91	Cape Pembroke, Falkland Islands	51 41 S	1895-1940
92	Islote de los Evangelistas, Chile	52 24 S	1901-1934
93	Punto Arenas, Chile	53 10 S	1888-1940
94	Grytviken, South Georgia	54 13 S	1905-1940
95	Laurie Island, South Orkneys	60 44 S	1903-1940

* also 1732-1735; ** also 1738-1759; *** also 1880-1895
# also 1848-1858

TABLE 2.

LEGEND FOR LETTERED CIRLCES IN FIG. I

Phenomena Other Than Temperature

A	Arizona Tree Rings (Lucachukai)	36 30 N	895-1939
D	Deaths (all causes) Massachusetts	42 N	1865-1945
J	Java Tree Rings	7 S	1514-1929
M	Terrestrial Magnetism (u-value)	Equator	1872-1945
N	Alaska Tree Rings (Nulato)	64 45 N	1800-1947
P	Pennsylvania Tree Rings (Warren)	42 N	
T	Deaths (Tuberculosis) (Massachusetts	42 N	1861-1945
V	Vermont Tree Rings (Fairlee)	43 54 N	1544-1934
Y	Yukon Tree Rings	61 N	1773-1942

THE 41-MONTH CYCLE IN STOCK PRICES

IS the 41-month cycle in common stock prices beginning to come back, but upside down as predicted?

Mr. G. T. Lane, of Rochester, New York, believes that it may be.

His belief is based on manipulations which he has made of the Dow Jones Industrial Averages, as charted on the two pages next following.

Let me explain this chart to you so that you can see the basis for Mr. Lane's belief.

Three Curves

The chart consists of three curves, each of which goes all the way across the two pages three times. The first time across the two pages covers the years 1897 through 1916. The second time across covers the years 1917 through 1936. The third time across covers the years 1937 through 1956.

Let me now explain how Mr. Lane got each of his three curves.

Curve C

Curve C is a purely arbitrary 40.6-month cycle introduced for purposes of comparison. It is a perfectly regular cycle with all crests 40.6 months apart from each other; all troughs 40.6 months apart likewise.

This arbitrary curve is symmetrical. It goes down for the same number of months (20.3) as it goes up. It is the regular cycle with which you are to compare the other two curves.

Curve B

The heavy solid line, labeled B, was obtained as follows:

Mr. Lane first smoothed the Dow Jones Industrial Averages with a centered 12-month moving average.

He then computed a 41-month centered moving average of these smoothed figures.

He then figured for each month the percentage that the 12-month moving average was of the 41-month moving average. It is these percentages that are plotted as Curve B.

Such a manipulation eliminates trend and minimizes the other long and short cycles and random numbers present in any series of figures so that you can see cycles in the general neighborhood of 41 months more easily. The result of this manipulation is that the 41-month cycle appears more clearly than in the actual figures themselves.

You can easily see peaks in Curve B at years 1899, 1902, 1906, 1909, 1912, 1916, 1919, 1922, 1925, 1929, 1933, 1937, 1939, 1943, and 1946, roughly corresponding to the peaks of Curve C.

You can also see strength in 1948 and in 1951 where Curve C suggests that there should be weakness. It is this strength that leads Mr. Lane to believe that the 41-month cycle is beginning to reverse.

Unless you are a technician you will probably wonder why Curve B stops in December 1951 instead of continuing up to date. The answer is that by its method of computation, a 41-month moving average loses 20 months at each end, and a centered 12-month moving average loses 6 months at each end. A manipulation of the sort Mr. Lane made is therefore always 26 months behind the current figures. It cannot be helped.

Curve A

The thin solid line consists of another manipulation of the Dow Jones Industrial Averages. This manipulation also has the effect of bringing out cycles in the general neighborhood of 41 months which might be present in any series of figures.

Curve A consists of one half of the

20-month rate of change of the Dow Jones Industrial Averages from their beginning up through February 1954.

A 20-month rate of change curve is merely the percentage that the value for any month is of the month 20 months earlier. That is, Curve A is plotted at about 120% for September 1898 because the actual prices for September 1898 were about 140% of the actual prices for January 1897, 20 months earlier. Curve A has a value of about 114% for October 1898 because the actual prices for October 1898 were about 128% (two times 14) of the actual value for February 1897, 20 months earlier.

A rate of change of this sort eliminates trend, minimizes long cycles, minimizes many short cycles, but leaves cycles in the general neighborhood of 40 months only slightly effected.

As you can see by comparing it with Curve C, this curve shows a pretty clear 41-month cycle up to 1946. However, the crest, due early in 1950, did not come until February of 1951. Moreover, throughout 1952 and the first eight months of 1953, Curve A went down instead of up as called for by the regular 41-month cycle (Curve C).

Cycle May Have Reversed

The behavior of this curve tended to strengthen Mr. Lane's belief that the 41-month cycle in Dow Jones Industrial Averages may have reversed as forecast by his own work of 1950. This work was presented to our members at the May 1950 meeting in New York City.

I am sure that Mr. Lane would be the first to agree with me in thinking that these charts do not *prove* that the 41-month cycle has reversed. They merely *suggest* that it may have. The next cycle or so should give us firmer grounds for an opinion one way or the other.

As I said in the Postscript to Chapter VIII printed in the March report, I am more than ever convinced that the 3½-year (41—42-month) cycle, which dominated the fluctuations of so many series of figures for so many years, is *not* the result of random forces. I am sure that it is significant.

On the other hand, I have become equally convinced that these fluctuations are not the result of a simple rhythmic force of the observed length, but rather that they are the result of the interplay of several (probably four) cyclic forces, all of this general order of magnitude.

We have underway at the present time a study of this cycle as it appears in tree rings over a period of more than a thousand years. I am hopeful that this study may clear up some of the mystery in regard to this particular cycle length.

Significance: If the so-called 41-month cycle in common stock prices has really reversed, this fact introduces an element of weakness, starting in the spring of 1954.

More important is the significance from the standpoint of cycle study. If, on the basis of fifty years or more of experience we can predict that, in the future, *just the opposite* will happen, and if this prediction is fulfilled, it shows that we are beginning to learn something about our subject. *E.R.D.*

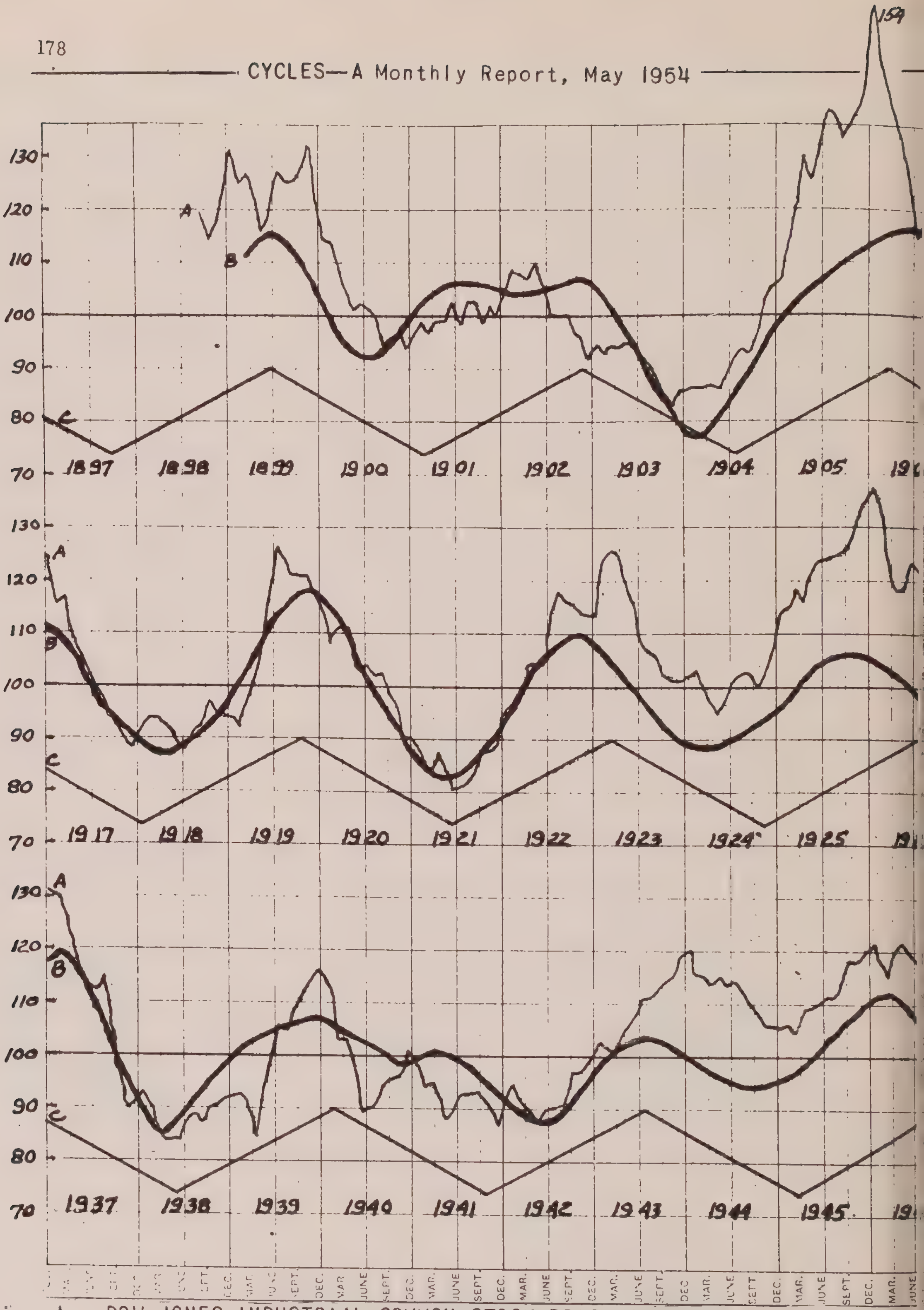
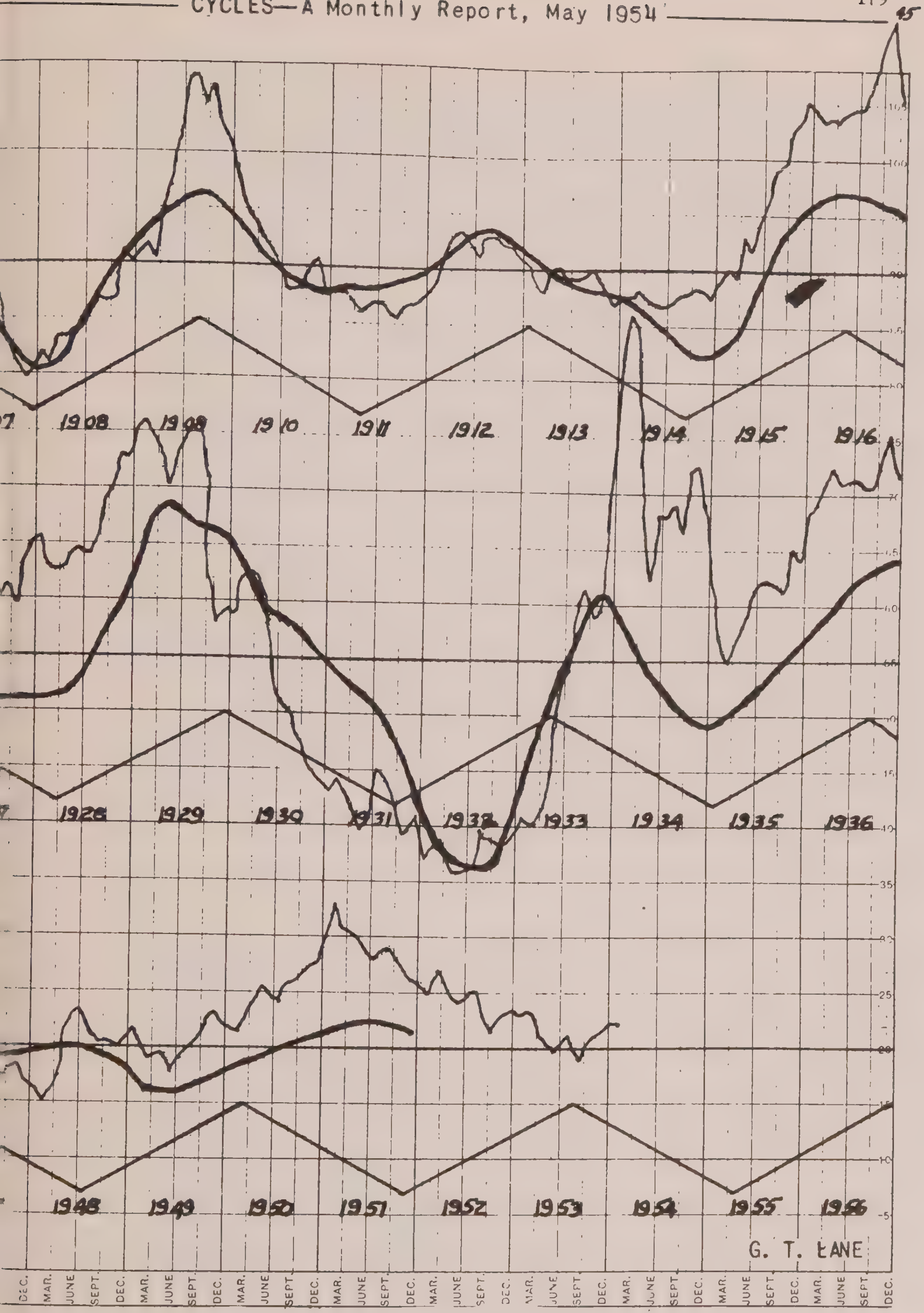


Fig. 1. DOW JONES INDUSTRIAL COMMON STOCK PRICE AVERAGES, MANIPULATED
TO SHOW THE 41-MONTH CYCLE

Curve A One half of a 20-month moving percentage of the averages.



B The averages smoothed by a centered 12-month moving average expressed as percentages of the corresponding 41-month moving average of these smoothed values

C An arbitrary ideal 40.6-month cycle added for purposes of comparison.

How it Came Out

THE 6-YEAR CYCLE IN SEARS, ROEBUCK

THE net sales of Sears Roebuck & Co. tend to fluctuate in a 6-year cycle. As far as I know, this fact was first observed in 1949. The behavior has continued for the five years since discovery. I feel that this cycle in these figures is not present as a result of random forces. I feel confident that it will continue.

The 6-year cycle is only one of a number of cycles that are present in Sears sales. To forecast these sales you need to take all these cycles into account You also need to take into account normal growth trend of these sales, the future course of inflation (because the sales are measured in dollars), and accidental factors as well. Truly, the lot of the forecaster is neither easy nor happy!

Net sales of Sears Roebuck & Company, 1907—1953, are charted (on ratio scale) in Fig. 1 below.

Fig. 1 also shows, by means of a broken line, a 6-year moving average trend of the sales. This trend represents the combined effect of growth, inflation, longer cycles, and random distortions of major proportions.

The 6-year cycle can be seen readily by inspection. Crests of a perfectly regular ideal 6-year cycle are indicated by arrows.

You can see the 6-year cycle more clearly if you express sales as percentages of trend. This has been done in Fig. 2.

Fig. 2 runs only from 1910 through 1950 because a 6-year moving average trend loses three years at each end of the series of figures. Three years from now we can bring the curve in Fig. 2 up through 1953. There is no way of knowing at the present time whether or not we are experiencing a crest. It all depends upon whether or not a decline is going to follow, and this, of course, no one on earth knows at the present time.

Back in 1949 the curve in Fig. 2 could be drawn only to 1945. In Fig. 2 as printed herein, the curve from 1945 through 1950 is pictured as a thick line to show you how the 6-year cycle has unfolded since it was discovered. On the whole very well, don't you think?

Fig. 2 also has a broken zig-zag line to represent the timing of a perfectly regular 6-year cycle.

By comparing the percentages of trend shown in Fig. 2 with this perfectly regular 6-year cycle, you can notice the following facts:

1. The crest in 1948 came exactly on time as forecast.
2. Of the seven crests, two came exactly on time, two came one year early, three came one year late.
3. Of the six troughs, five came exactly on time, one came one year early.
4. The current crest is due in 1954.
5. *Ideally* three years of decline *relative to trend* can be expected to follow.

Now that we have five more years of figures it is possible to re-examine the timing and the amplitude of the six-year cycle. This re-examination shows that the timing does not change from the timing as determined in 1949. However, using the additional figures now available it appears that the typical amplitude is slightly greater than it seemed at that time. As nearly as I can judge it, the crests of this cycle account for strength about 10% above trend, the troughs account for weakness about 10% below trend. From crest to trough, therefore, this cycle accounts typically for a move of 20% of trend or an average of 6 2/3% of trend per year.

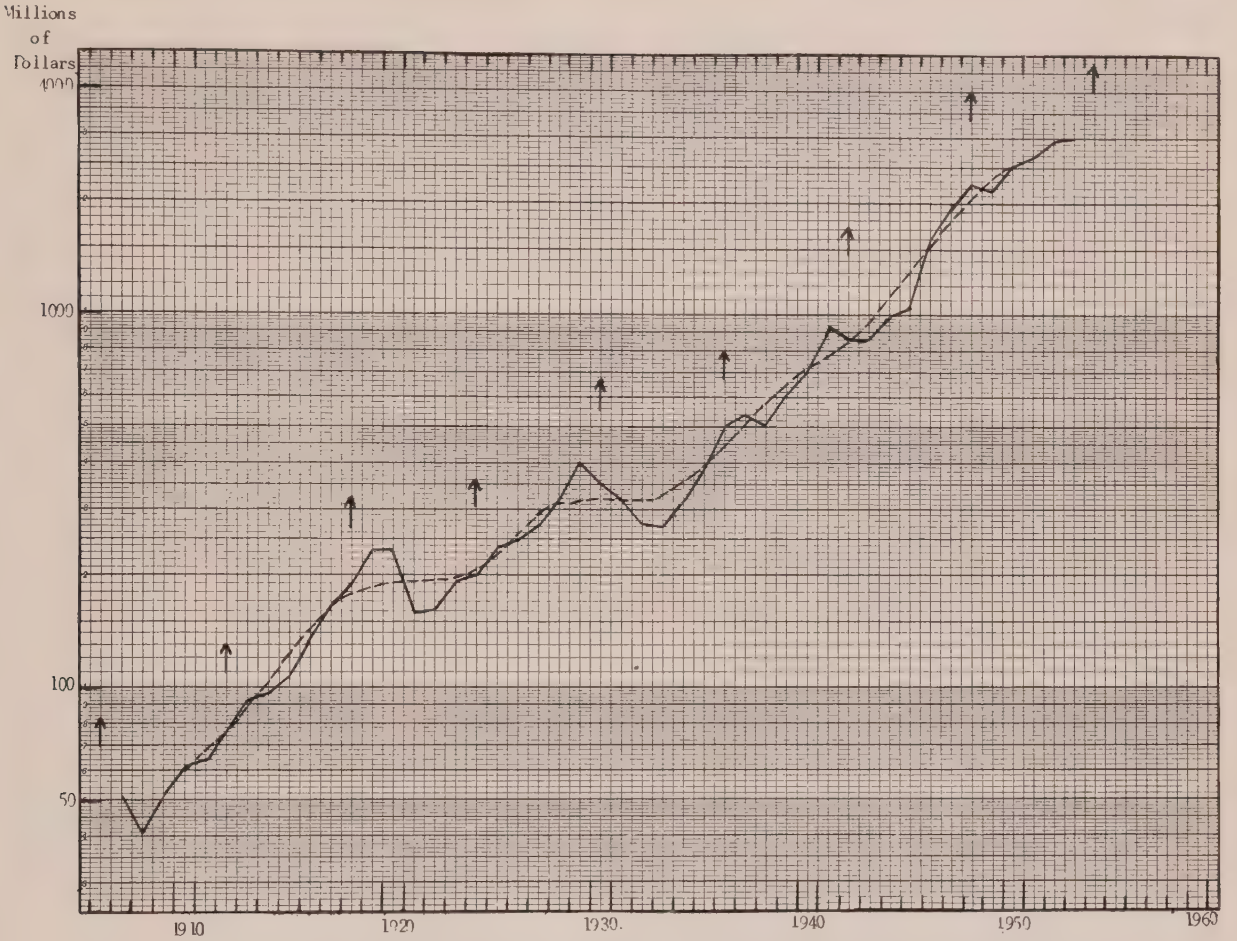


Fig. 1. Sears, Roebuck and Company Net Dollar Sales 1907—1953, Together with a 6-Year Moving Average Trend. Arrows indicate times of ideal highs of the 6-year cycle. (Ratio Scale.)

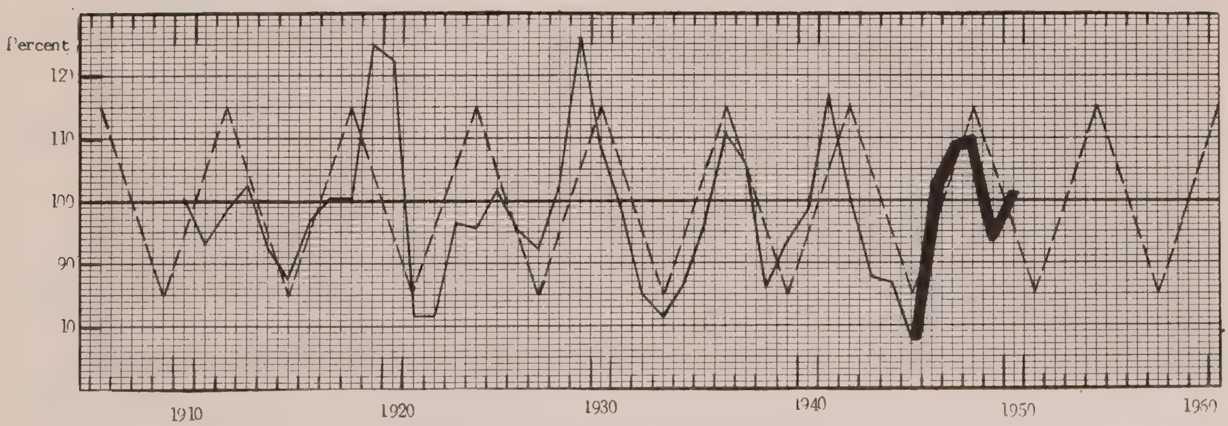


Fig. 2. The 6-Year Cycle in Sears, Roebuck and Company Net Dollar Sales. This chart shows the percentages that the sales for each year are of their 6-year moving average trend. As the trend, by its method of construction, loses three values at each end of the series of figures, this curve runs only from 1910 through 1950. The heavy line from 1954 through 1950 shows how this cycle has worked out since original discovery.
The timing of the ideal 6-year cycle has been diagrammed by means of a broken zig-zag line. This zig-zag has been projected to indicate the probabilities of the future.

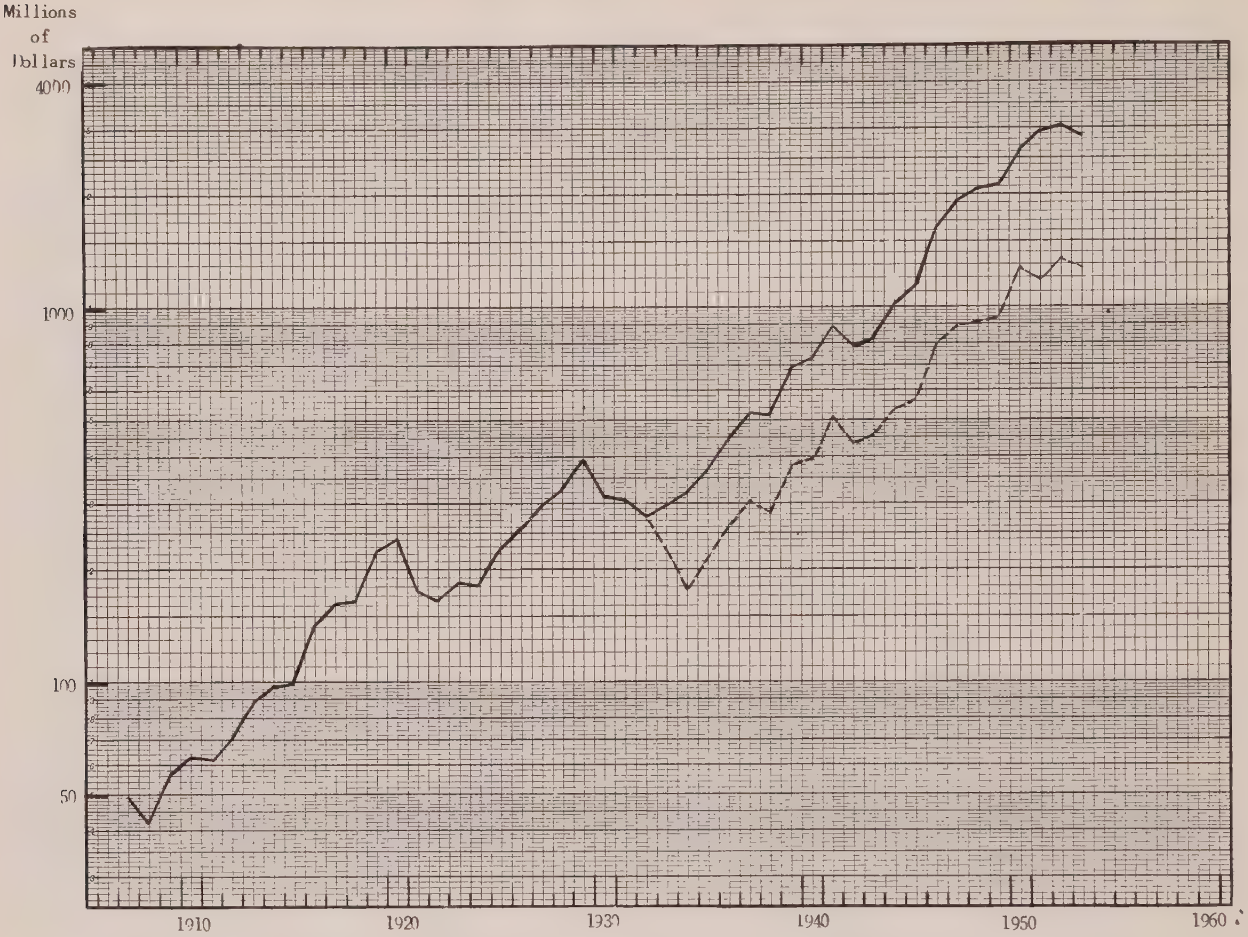


Fig. 3. The solid line shows net dollar sales Sears, Roebuck and Company 1907—1953 adjusted for effect of the perfectly regular 6-year cycle. This curve shows what sales would have been if there had been no 6-year cycle. It reveals trend, inflation, accidental factors, and other cycles more clearly.

The broken line 1932—1953 adjusts the solid line to a gold basis. That is, it shows sales in gold dollars instead of paper dollars. By eliminating the inflation factor this curve gives a more accurate representation of the true growth of the company. (Ratio Scale.)

If we adjust the net sales, 1907—1953, for the effect of a perfectly regular 6-year cycle of the properties named we get the solid line in Fig. 3. This is what Sears sales would have been if there had been no 6-year cycle. This curve shows all the elements in these sales, *other* than the 6-year cycle, namely, inflation, the other cycles, and the random fluctuations.

As we know year by year how many paper dollars could be bought on the black market with real honest-to-goodness gold dollars it is easy to remove the inflation element in Sears sales by a simple adjustment. This has been done. The results are plotted by means of a broken line. This simplifies the curve a little.

Examination of this last named curve suggests several additional cycles. When I can find the time I shall attempt to unscramble them for you.

In the meantime, as I told you above, following the current year (1954), the probabilities call for three years of relative decline. *E. R. D.*

THE FORECAST OF CONTINENTAL OIL COMPANY INCOME

IN our report for June 1953 I told you that the gross operating income of Continental Oil Company 1930—1952 was chiefly characterized by a 6-year cycle, a 3½-year cycle, and a gradually flattening underlying growth trend. I said further that if these three elements continued we could expect two more years of increasing sales (1953 and 1954) to be followed by a decline.

The projection made at that time is charted below, together with sales for 1953 as they actually unfolded. Sales increased to $476,000,000.00 instead of to $414,000,000.00 as forecast. The direction of the forecast was right but it did not call for as much advance as actually occurred.

Now that we have another year of figures it is possible to re-evaluate and perhaps refine the amplitude and timing of the cycles and the slope of the trend. This will be done for you in an early report.

The chief revision will doubtless be in the slope of the trend, which probably is not quite as flat as it seemed in 1953. Thus, the revision will probably raise the forecast for 1954 and subsequent years, without, however, changing its general shape.

E.R.D.

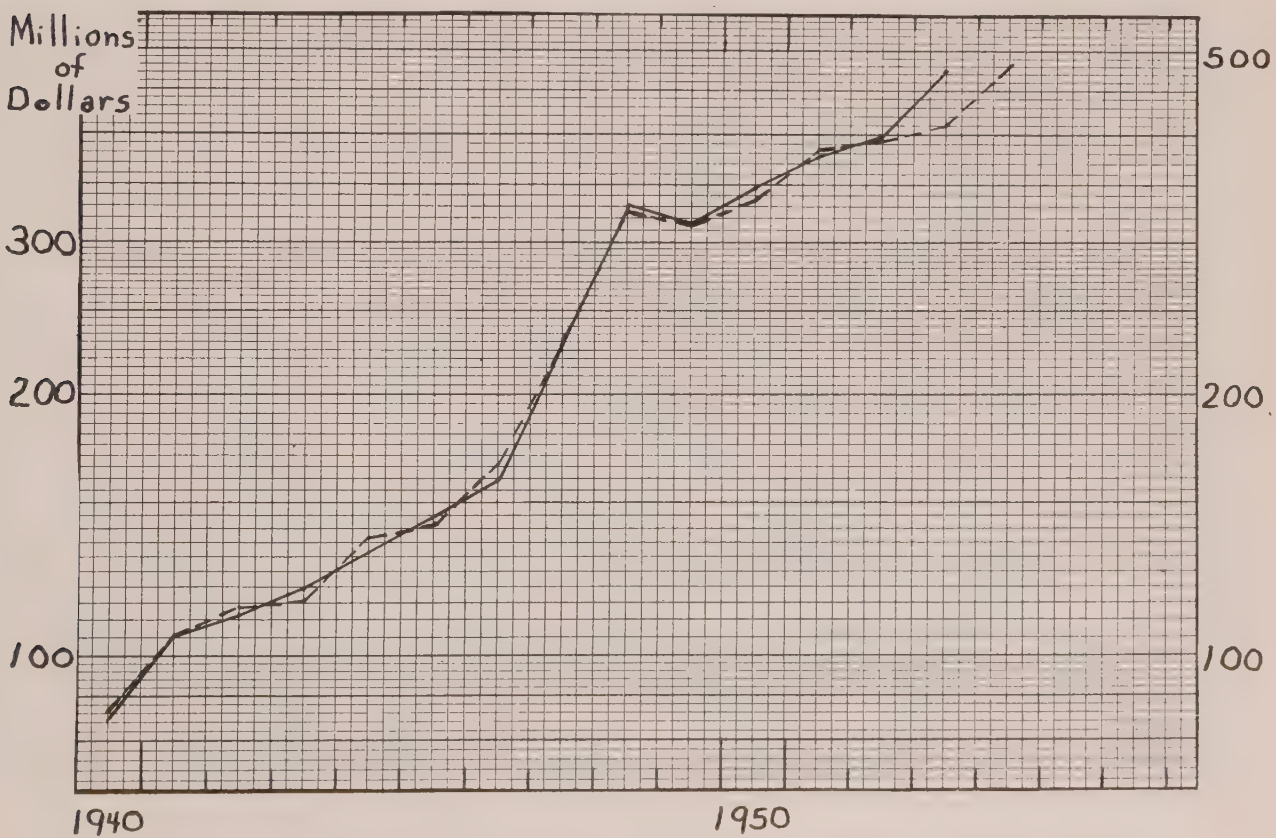


Fig. 1. Solid line, Gross Operating Income Continental Oil Company, 1940—1953. Broken line, synthesis of cycles and trend made from figures up to 1952.

THE 8-YEAR AND 6-YEAR CYCLES IN GOODYEAR TIRE AND RUBBER COMPANY SALES

SOMETIME back (January 1954) I printed for you a diagram showing the combined effect of the 8-year and 6-year cycles in the sales of the Goodyear Tire and Rubber Company. This diagram is reproduced below. It is based on behavior 1926 through 1952. The diagram calls for an increase from about 115% of trend in 1952 to about 125% of trend in 1953—an increase of about 8½%.

Figures for Goodyear for 1953 are now available. The 1952 figure was $1,138,400; the 1953 figure is $1,210,500. The increase amounts to 6 1/3%.

As the 6-year cycle and the 8-year cycle in the sales of Goodyear Tire and Rubber Company could easily have been determined a number of years ago (as a matter of fact, the 6-year cycle was actually isolated in 1949) anyone who wished could have had foreknowledge of the probabilities of an increase from 1952 to 1953.

Similarly, as I said in the earlier report, following a peak in 1953 *normal* behavior calls for a decline in these figures for about three years to a low in 1956 of 30% below trend. Thereafter there should be a rapid and important recovery.

As I am sure you realize, this projection, like a weather forecast, cannot be counted upon absolutely. It is merely a

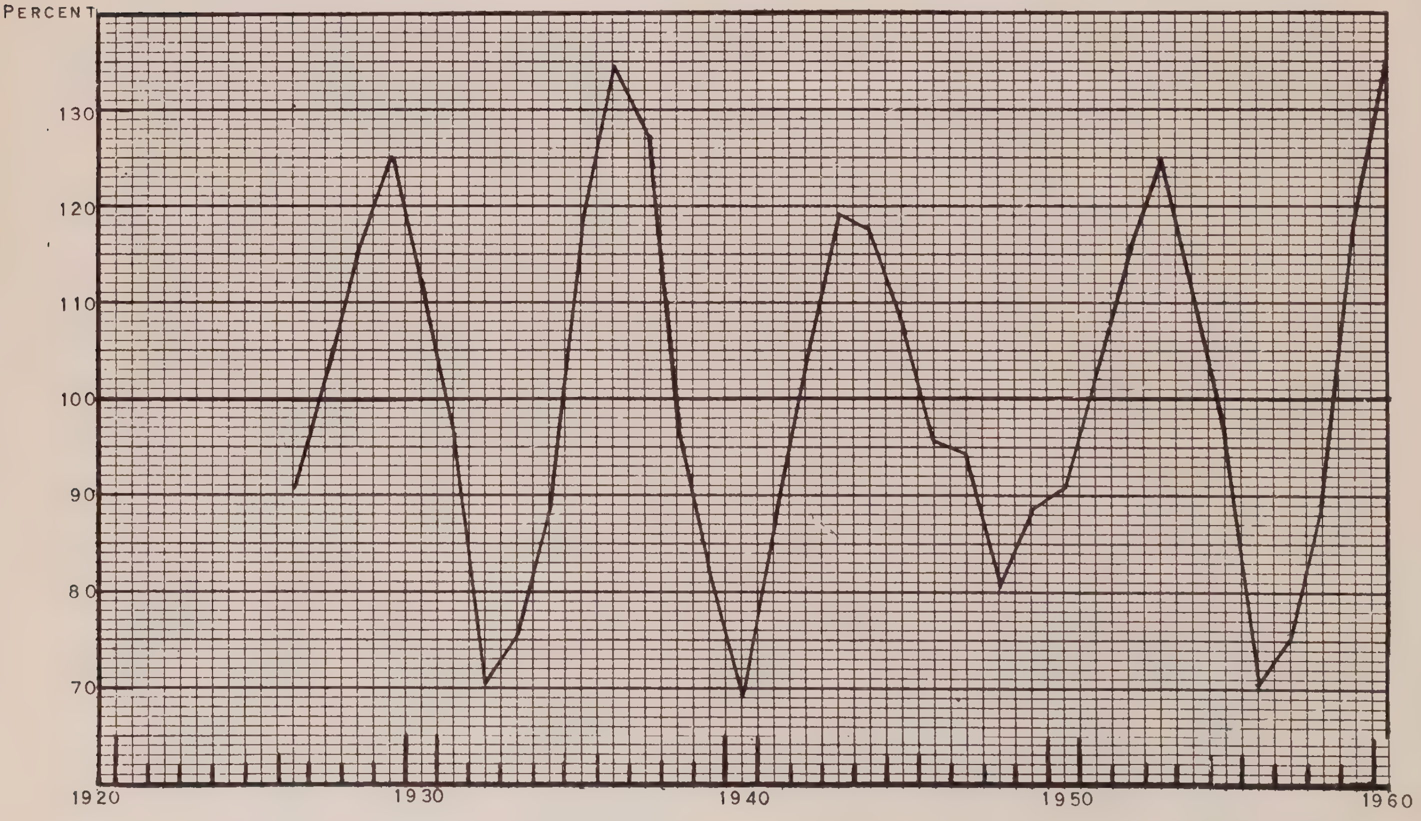


Fig. 1. A Synthesis of the Ideal 8-Year and the Average 6-Year Cycle in Goodyear Tire and Rubber Company Net Sales, 1926-through 1960.

statement of probabilities.

* * *

When I initiated my study of cycles in the sales of the Goodyear Tire and Rubber Company the earliest figures the company was able to furnish me were those for 1926. A series of figures as short as this gives us only about three repetitions of an eight-year cycle. This is very little to go on.

If we could only get 10 or 15 earlier figures to see if the cycle continued backward in time it would be just as good as waiting until 1960 or 1965. It is just as convincing to have a cycle continue backward as to have it continue forward. The cycle clock runs either way.

Today, in bringing up to date the sales of another great rubber company, the B. F. Goodrich Company (figures for which company are available from 1912) it occurred to me to compare the 1926—1953 sales of the two. If these were alike for the period 1926 through 1953 it could be assumed that they might have been alike for the period of 1912—1925. Then, by examining to see how the 8-year cycle came out in Goodrich, we could get some light on how it might come out in Goodyear, if we could get the earlier figures for the latter company.

The comparison is shown in the chart below. From 1926 through 1953 the two curves are found to be much the same. The 8-year cycle is clearly evident in the sales of both. As we go backward in time we see that in Goodrich sales the 8-year cycle continues as indicated by the arrows. This behavior of course does not *prove* that it was present in Goodyear, but it certainly suggests that it probably was.

Even five cycles is not very much to go on, but I feel a lot better about the Goodyear projection. Five cycles may not be very many, but it is ever so much better than three cycles. In projecting a cycle based on only three repetitions I was skating on pretty thin ice.

E.R.D.

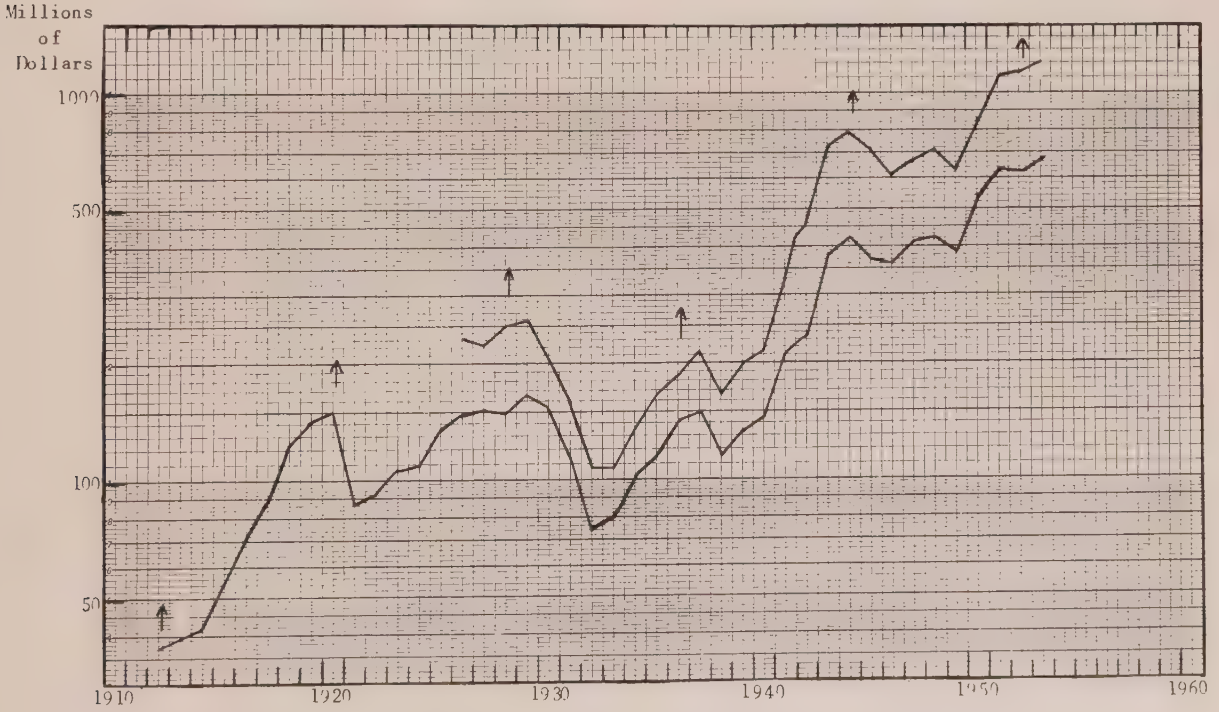


Fig. 2. Upper Curve: Goodyear Tire and Rubber Company, Net Sales 1926—1953.

Lower Curve: B. F. Goodrich Net Sales, 1912—1953.

Arrows indicate crests of 8-year cycle. Note that this cycle continues backward from 1926. (Ratio Scale.)

THE 6-YEAR CYCLE IN DU PONT

IN 1949 I observed that the sales of E. I. du Pont de Nemours Company, 1925—1948, showed clear evidence of a 6-year cycle. I told you about this cycle in our report for December 1950.

A 6-year cycle has been found in the sales and/or production of many other companies and in many aspects of natural science as well.

Sales to customers of the du Pont Company are charted in Fig. 1. This chart also shows the six-year moving average trend of these figures.

Fig. 2 shows the percentages that the actual sales are of trend. As the trend cannot be computed for the first and last three years, the percentages of trend for these years are missing also. The heavy line, 1945—1950, shows how the 6-year cycle in these sales has been working out since discovery.

To aid you to follow the cycle, I have added a diagram of the ideal 6-year cycle. The shape is peculiar and suggests the concurrent presence of another cycle.

As you can see, the 6-year cycle has not worked out satisfactorily. In fact, as you study Fig. 2 you can see that the 6-year cycle has been getting smaller and smaller with each successive wave, until now it has just about vanished.

Three explanations are possible: (1) The 6-year cycle may have been present in these figures, 1925—1948, merely by accident. (2) With the company's increased size, changing products, and greater diversity, the 6-year cycle may have faded out. (3) Some other cycle of closely related length may temporarily be offsetting the 6-year cycle formerly present in these figures.

As a practical matter it does not matter very much what the explanation is. The cycle is no longer present in significant proportion. Until it reappears you had best forget it in the sales of du Pont and Company.

E.R.D.

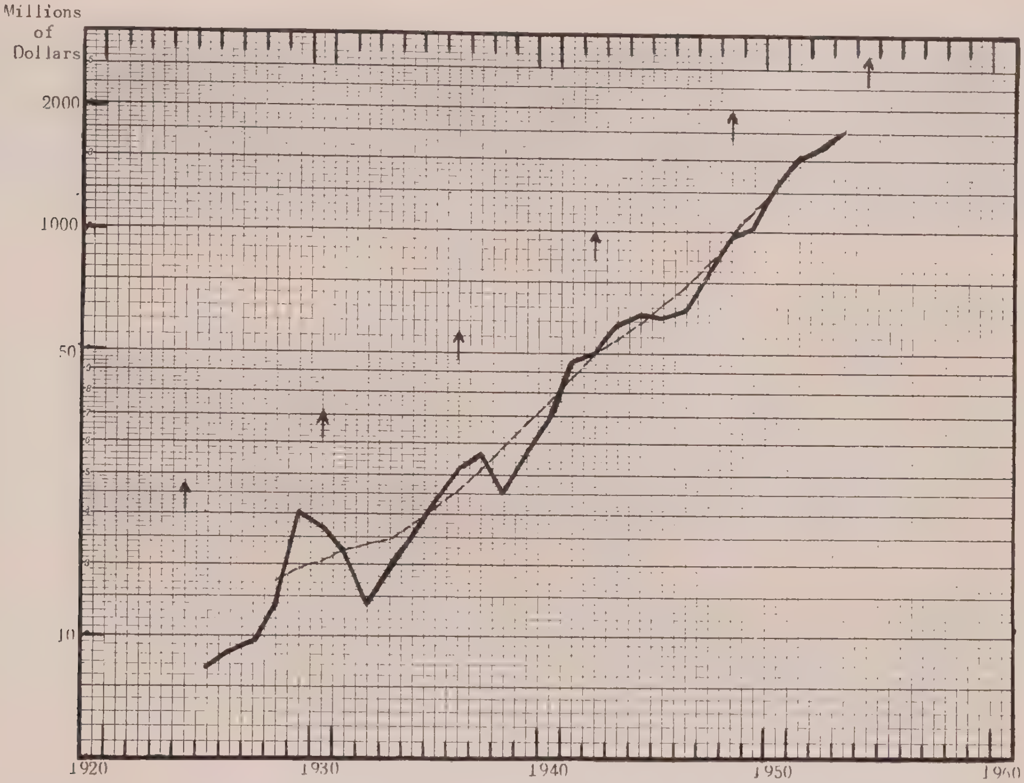


Fig. 1. E. I. du Pont de Nemours and Company Dollar Sales to Customers, 1925—1953, together with a six-year moving average trend. Arrows indicate time of ideal high of six-year cycle. Ratio Scale.

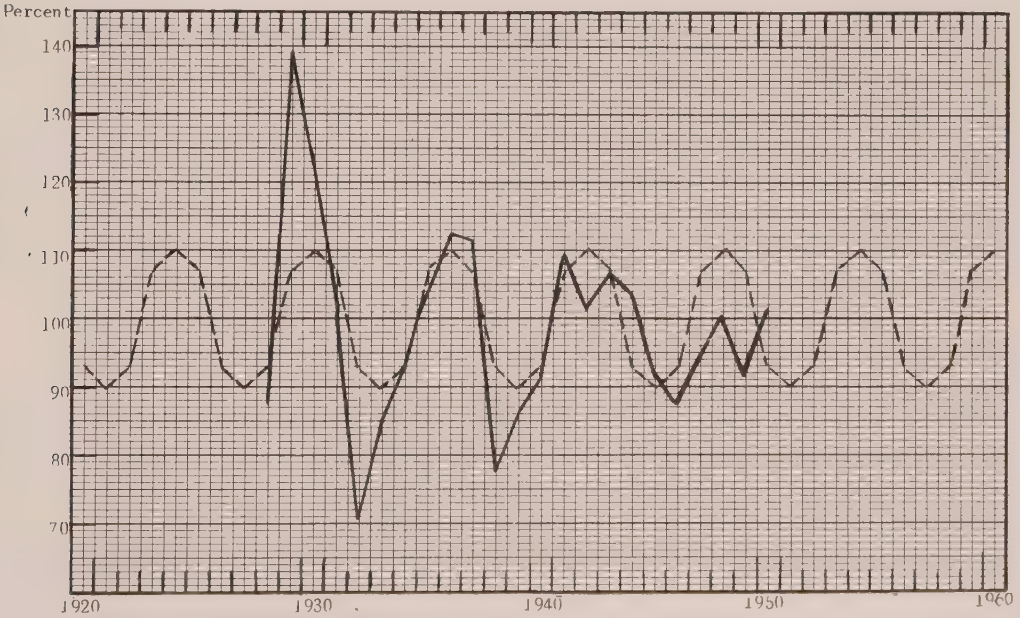


Fig. 2. The Six-Year Cycle in du Pont Dollar Sales to Customers, 1928—1950. Deviations of the actual sales from their six-year moving average (as the trend loses three values at each end of the series, deviations are lacking for three years at each end also).

Questions & Answers

Question:

What is meant by the term synthesis?

Answer:

It means a putting together. When we have several cycles, we synthesize them to find out the composite effect at any given mement.

Question:

Of what use is a synthesis of cycles when it cannot possibly take into account natural economic phenomena such as wars and depressions?

Answer:

Depressions are probably largely the result of cycles. If you know all the cycles involved, you probably would have a pretty good picture of coming depressions.

Wars are different.

Even though there is evidence that wars come at cyclic intervals, the economic effect of different wars is very different and for all practical probabilities the *effect of war* cannot be foretold by a knowledge of cycles. Your question, therefore, might be rephrased, "What is the use of a knowledge of cycles when they give only partial information?" The answer is: partial information is better than none.

Question:

Does a big business tend to monopolize little business in an upward sweep of the cycle?

Answer:

I do not know.

Question:

What is a moving average of commodity prices?

Answer:

If you average commodity prices for 1910-1911-1912, you would get a value typical of the three years centered at 1911. You could then average the prices for 1911-1912-1913 and get the typical value for the three years centering in 1912. An average computed this way is called a moving average or an overlapping average.

Because you average three years at a time, the example given would be a 3-year moving average. If you would average five years at a time, it would be a 5-year moving average, and so on.

Question:

Is it safe to assume that in 1990 we will reach a peak of prosperity and then start on our way for a bad depression?

Answer:

Definitely not. You cannot pin-point things as closely as that. A knowledge of cycles is of *help*. But do not over-work a good tool.

The cycle chart of weather shows February 15 as typically the coldest day of the year, but this does not mean that the coldest day of the winter of 1954-1955 will fall even within even a month of the ideal time.

Question:

If we expand, will the depression and inflation periods become more severe with each period?

Answer:

There is no reason to believe that, *percentagewise*, periods of depression and inflation will get worse as we get bigger. But of course in absolute terms the bigger we are the bigger the fluctuations.

EXCERPTS FROM

CYCLES

THE SCIENCE OF PREDICTION

(CHAPTER X)

by EDWARD R. DEWEY
Director, Foundation for the Study of Cycles

and EDWIN F. DAKIN
Associate, Foundation for the Study of Cycles

TOGETHER WITH 1954 SUPPLEMENT

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X

Causes, Correlations, Conjectures

IN THE FOREGOING ANALYSIS of rhythms in our economy we have confined our description to the four which may be regarded as the most important of the many that have been isolated. These four are, to summarize:

A. The 54-year rhythm in wholesale prices and industrial innovations.
B. The 9-year rhythm in wholesale prices, security prices, pig iron production, and industrial activity.
C. The 3½-year rhythm in security prices and in business activity, wholesale and retail.
D. The 18-year rhythm in real estate activity, and in related industrial enterprise.

Various other economic rhythms have been observed. Figure 1, for instance, shows a 33-month rhythm in residential building activity. A rhythm of this length is also important in many lines of retail trade, and in consumers' goods production. A 23-month rhythm in textile production is illustrated in Fig. 2. This length is also found frequently. Figure 3 shows a 34-day (i.e., market day) rhythm in the rate of change of prices of raw sugar. Figure 4 shows Professor Pearson's index of the purchasing power of beef cattle prices,* together with a true 14.8-year periodicity added. Similar rather regular rhythms appear in the prices for horses, with peaks around 25 years apart, and also in the prices for various other livestock. Figure 5 shows a chart, suggested by a study by Pearson, Cassetta, and Bennett, illustrating a very regular rhythm in pepper prices, with peaks at approximately 15-year intervals. Figure 6 shows a 3-month wave, also often found present in economic phenomena.

These rhythms are introduced here merely to illustrate the diversity of the forces with which we must deal; there are many others.

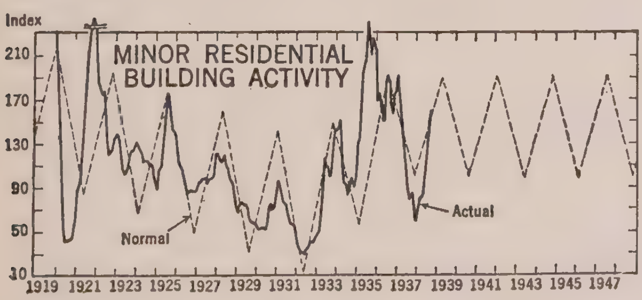

FIG. 1. RESIDENTIAL BUILDING

The 33-month rhythm in residential building activity, 1919–1939. Rate of change. A 12-month moving percentage of actual data, together with a regular 33-month cycle (after Pearson). The regular cycle has been extended to show approximately what will happen if the rhythm continues.

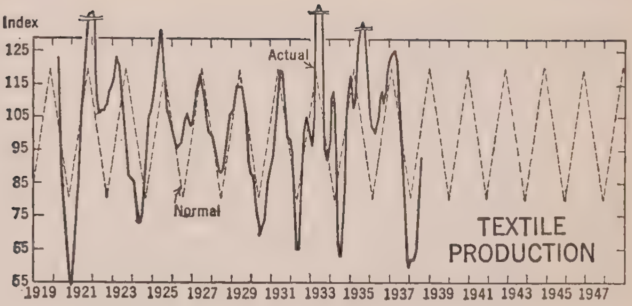

FIG. 2. TEXTILES

The 23-month rhythm in textile production, 1919–1939. Rate of change. A 12-month moving percentage of actual data, together with a regular 23-month cycle (after Pearson). The regular cycle has been extended to indicate approximately what will happen if the rhythm continues.

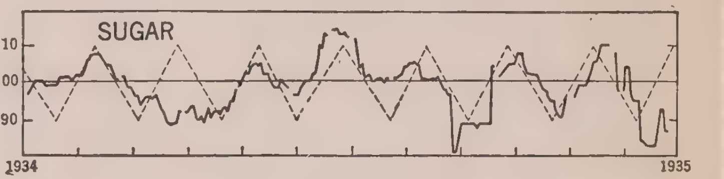

FIG. 3. SUGAR PRICES

The 34-market-day rhythm in raw sugar prices, 1934. Rate of change. A 16-day moving percentage of actual data, together with a regular 34-market-day cycle. This tendency persists before and after 1934, as does the tendency for every third wave to be greater.

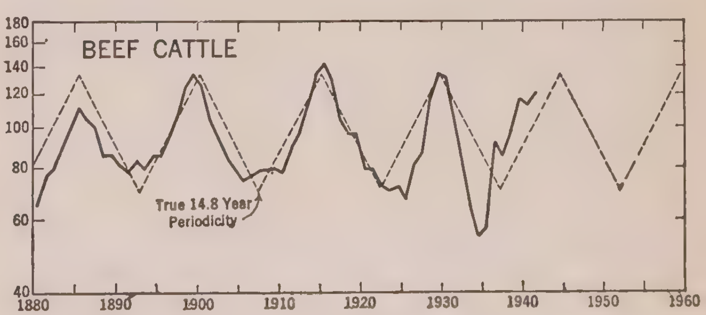

FIG. 4. CATTLE PRICES

The 14.8-year rhythm in the purchasing power of beef cattle prices. Professor Pearson's index is charted here, and a regular 14.8-year cycle has been added. The cycle has been projected to show more or less what will happen if the rhythm continues. *Ratio scale.*

---

* Dividing the price of a given commodity, X, by an index of prices of other commodities, eliminates the effects of all the factors common to both X and the other commodities. It gives a quotient, the purchasing power of X, which provides some indication of the factors peculiar to that particular commodity.

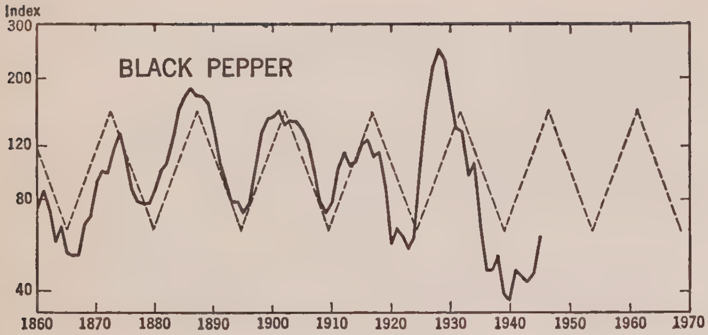

FIG. 5. PEPPER PRICES

The 14.8-year rhythm in the wholesale prices of black pepper. A regular 14.8-year cycle has been added and projected, to show more or less what will happen if the rhythm continues. (After an idea by Pearson, Cassetta, and Bennett.) *Ratio scale.*

These economic rhythms, as we have already noted, need to be read — like the hands of a clock — in conjunction with each other. And because they are repetitive they may be combined, together with a trend, to obtain a great deal of light on the near future of the economy.

But before reaching that problem in synthesis, it seems well to pause here briefly to answer the reader who is curious about causes. What is the cause of these rhythms? Can we really accept anything as true until we know the cause of it? If we judge by the progress made in other sciences, we can well understand that ultimate cause is an extremely difficult factor to discover. It is more a problem for philosophy than for science. Nor is it even admitted, in some fields of thought, that we shall ever discover ultimate cause at all — on the theory that finite mind is by its very nature unable to understand the ultimate working of an infinite universe. But in the study of various rhythms in our environment and in ourselves, research workers have at least made great progress in isolating some significant data.

In the various categories of rhythms we know, some are as familiar to the man in the street as day and night and the tides; others are relatively unknown to him. Analytical work on these rhythms has been developing in what might be called the interstices of the sciences. We have as yet only the beginnings of a science of rhythms *per se.* But in each field of science some group of workers becomes especially concerned with the subject of rhythms in the special field of phenomena he is observing; such a group eventually compares notes with a corresponding group engaged in some other scientific field; and slowly all concerned begin to suspect that they are dealing, however diverse the fields, with phenomena somehow related.

The object of all true scientific inquiry is to find the simplest possible explanation to cover the greatest possible number of diverse phenomena. The further we go in science, the more we become convinced that the universe is a unity, that its laws of action are relatively few and simple, and that they apply to all things. We thus have a right to suspect, when we find rhythms present in so many kinds of phenomena which our sciences study, that we may be dealing with related parts of a whole.

We must guard, of course, against confusing *relationships* with *causes.* Suppose, for instance, that a meteorologist found a rhythm of exactly 41 months in the weather, and that we already knew of an *exactly* similar rhythm in the stock market. This would not justify us in concluding that the weather caused rhythms in the stock market. Perhaps some other unknown factor affected the weather together with the people who buy and sell in the stock market. Conceivably they could be totally unrelated — although this would seem hard to believe. Until we were sure, we could only speak of relationships, or of *correlations* — this last being a technical term for a particular measure of relatedness.

The study of rhythms has not yet proceeded beyond problems in correlation. Even to this point our progress has been wavering and uncertain. The greatest single piece of progress to date, in the study of economic phenomena, has undoubtedly been the recognition that we are in fact often dealing with *rhythms* rather than mere oscillations. This recognition has recently changed the whole focus of economic inquiry. Until it was reached, millions of words had been written in the quest for *reasons* for economic changes. Pursuing such a method of inquiry the old economics had made little progress toward becoming a true science. Rather, it became a larger and larger debating society, devoted to examining reasons why a given event should cause some particular result.

The mere abundance of such reason-why material — so great that no student could ever master it, reconcile it, and put it to practical use — was itself evidence that the method was fruitless. True scientific progress is measured in the growing ability to reduce the essential laws and relationships in a given field of inquiry into small compass, and to predict. In fact, it is possible to assert that the ability to predict measures the status of a science.

With the discovery of rhythm in economic phenomena, some economic inquiry immediately changed direction. The question was

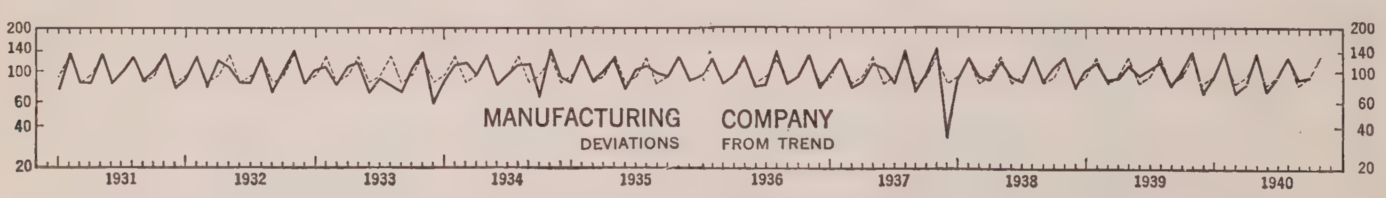

FIG. 6. SALES OF AN INDUSTRIAL COMPANY

The three-month rhythm in the sales of a large industrial company. Curve shows deviation from 3-month moving average. A 3-month cycle is added.

no longer *why* we have business cycles, and *why* we meet recurrent economic slumps. Now the fundamental question was simply: Are the cycles really rhythmic? And if so, does the rhythm spring from within or without the economy?

To the first part of the query continued research has been able to give an affirmative answer almost beyond doubt. Some of the evidence is in the foregoing pages. In concentrating on the second part of the question, economic inquiry has produced theories that fall into two classes. Hotelling has referred to them as theories of "free and forced oscillations." Both terms are borrowed from mechanics.

"Forced oscillations" means rhythms caused by forces entering from outside the economic environment. Jevons, for instance, entertained a forced oscillation theory. He believed it possible to show that changes in the sun affected agricultural production, and the resulting changes in agricultural production eventually caused changes throughout the economy that registered themselves in factory production, prices, and even stock market values.

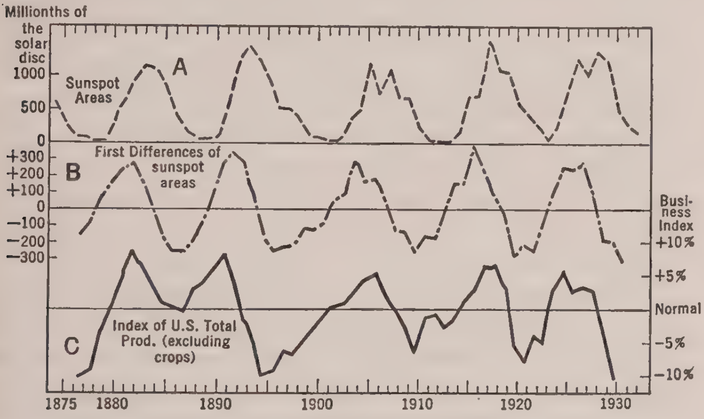

FIG. 7. SUNSPOTS AND PRODUCTION

A. Sunspot Areas, B. First Differences of Sunspot Areas, and C. an Index of U. S. Total Production Excluding Crops. B and C 4-year moving averages. (After Garcia-Mata and Shaffner.)

Many years later, in 1934, two Harvard research workers, Carlos Garcia-Mata and Felix Shaffner, re-examined the Jevons studies and checked them; they ended with the conclusion that sunspot phenomena showed no correlation with agricultural production, but— that solar phenomena showed a remarkable correlation with industrial production (see Fig. 7), business activity (Fig. 8), and with stock market prices (see Figs. 9 and 10). Since this particular outcome of their studies apparently left them a little surprised and aghast, the two students threw up their hands and passed the problem over to the biologists and the psychologists.

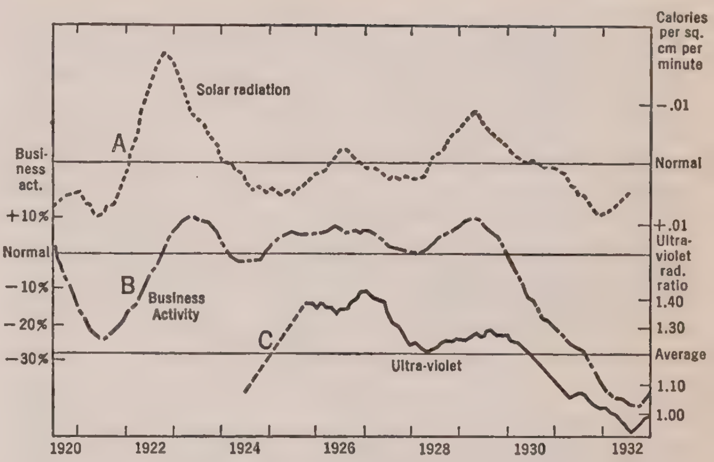

FIG. 8. SOLAR PHENOMENA AND BUSINESS ACTIVITY

A. Solar radiation — that is, variation of the solar constant — June 1920–June 1932, inverted. B. Col. L. P. Ayres Index of American Business Activity, June 1920–December 1932. C. Ultra-violet solar radiation, June 1924–December 1932 (after Garcia-Mata and Shaffner).

Although the period is too short for statistical deduction, the comparison is interesting.

It may be observed that — even though they had discovered an approach to the problem different from Jevons's — they were still dealing with "forced oscillation" data. Some of their data has since been confirmed by no less an astronomer than Dr. H. T. Stetson,* together with others, and it may be considered that Garcia-Mata and Shaffner made a real contribution to modern research. Further, in recognizing the psycholgical implications of their work, they have done much to enhance its scientific usefulness.

The other theory of economic rhythms — that referred to as "free oscillations" — has also been called the "random shock" theory. If, for instance, you take a pendulum and subject it to one or more random blows, it will start swinging in regular rhythm, as it is the nature of the pendulum to do. Exhaustive mathematical studies have been made with the purpose of demonstrating that our economy acts in the same manner, in response to events which come

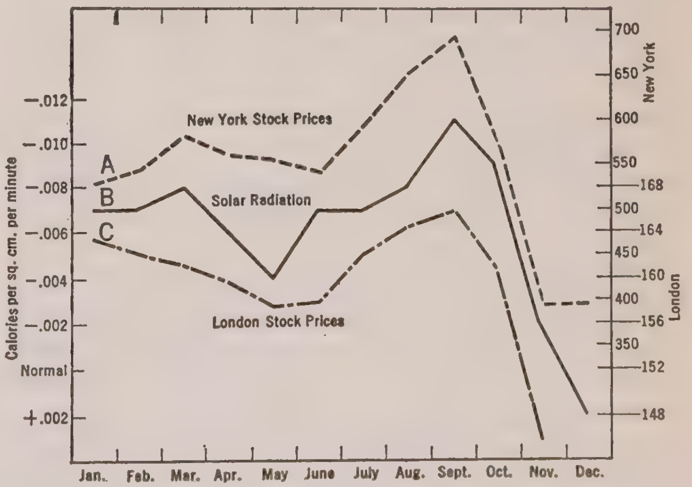

FIG. 9. SOLAR RADIATION AND STOCK PRICES

A. New York stock prices (Barron's average). B. Solar Radiation, inverted, and C. London stock prices, all by months, 1929 (after Garcia-Mata and Shaffner).

Correspondence between curves over a short period of time may be provocative, but by itself proves nothing except that for the period shown the curves do somewhat correspond.

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* Research associate, Massachusetts Institute of Technology, and director, Laboratory of Cosmic and Terrestrial Research. See his *Sunspots and Their Effects* (Whittlesey House, 1937).

as erratic shocks, but set up rhythmical responses. E. Slutsky has explained this point of view cogently in an essay, first published in 1927 in Russian, called, *The Summation of Random Causes as the Source of Cyclic Processes,* in which he said:

> The summation of random causes generates a cyclical series which tends to imitate for a number of cycles a harmonic series of a relatively small number of sine curves. After a more or less considerable number of periods every regime becomes disarranged, the transition to another regime occurring sometimes rather gradually, sometimes more or less abruptly, around certain critical points.

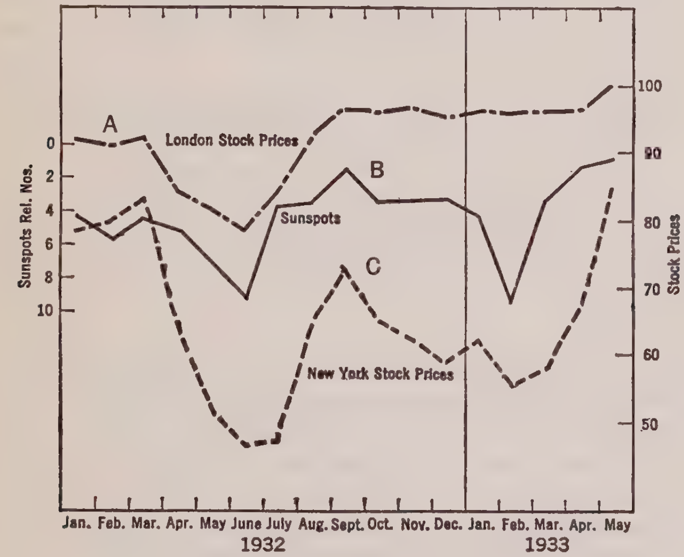

FIG. 10. SUNSPOTS AND STOCK PRICES

A. London stock prices (Banker's Magazine Index). B. Sunspots in the Sun's Central Zone, inverted, and C. New York stock prices (Dow-Jones Industrial averages), all from January 1932 through May 1933 (after Garcia-Mata and Shaffner).

Here again, the curves are much too short to warrant any deductions whatsoever. For an example, of two series that are presumably related see the curves of sunspots and terrestrial magnetism shown on page 64.

The "random shock" is the theory that Professor Schumpeter apparently prefers in accounting for the rhythms in the capitalist economy which he analyzes in his monumental *Business Cycles.* He finds it easy to believe that innovations, acting as such shocks, account for the cyclic movement.

This much deserves to be said: The resources of modern mathematics in the hands of our eminent mathematicians today are quite ample to demonstrate the *possibility* that random shock does account for our economic rhythms. But such a demonstration as to possibility is still far from final evidence that such shock, responded to with rhythm, is indeed the underlying "cause" of rhythmic economic fluctuations. There is no reason why it should not be accepted as a hypothesis by those who find it helpful. But in embracing it they should realize that, until we know considerably more than we do today, they are engaging in an act of faith.

Further, there are two characteristics of our economic rhythms that this theory apparently does not explain. First, it fails to tell us why, after a distortion, the rhythms snap back into phase with the old established pattern, as has been observed frequently. Second, it fails to account for the correspondence between so many of the economic and the "natural" rhythms.

Kondratieff, for whose work Professor Schumpeter expresses admiration, is himself unwilling to agree with the random shock theory: "In asserting the existence of long waves and in denying that they arise out of random causes, we are also of the opinion that the long waves arise out of causes which are *inherent in the essence* of the capitalist economy." * Kondratieff refrains from speculating on the problem of what this essence might be. Nor does he speculate on the obvious comparisons with biological organisms, where rhythm as an essence of the organism itself can actually determine whether the organism will respond to external stimuli or be unmoved by them. The rhythm in the sex life of women is an almost perfect parallel.

Kondratieff makes bold to assert, however, that causes usually assumed for our rhythms "reverse the causal connections, and take the consequence to be the cause, or see an accident where we really have to deal with a law governing the events." Sometimes improvements in technique have been alleged as a cause. But, says Kondratieff, it would be a great error "if one believed that the direction and intensity of those discoveries and inventions were entirely accidental. . . . The development of technique itself is part of the long waves." Similarly, it is a mistake to regard wars as causal: "Wars and revolutions can also be fitted into the rhythm of the long waves and do not prove to be the forces from which these movements originate, but rather one of their symptoms."

As for the results of exploration: "The opening up of new countries does not provoke the upsweep of a long wave. On the contrary, a new upsweep makes the exploitation of new countries, new markets, and new sources of raw materials necessary and possible." Nor does gold production play a causal part, as Kondratieff views it: "Gold production, even though its increase can be a condition for an advance in commodity prices and for a general upswing in economic activity, is yet subordinate to the rhythm of the long waves and consequently cannot be regarded as a causal and random factor."

Many other research workers who are working on evidence of "forced oscillation" have produced data of interest and significance. Dr. Huntington of Yale is a distinguished representative of these.

In his monumental work that shows the influence of climate on history, *Mainsprings of Civilization,* Dr. Huntington states his belief that we are dealing in our studies not with one force, but with three, which create three different kinds of rhythmic responses; he has summarized his conclusions as follows:

> Our most important finding is that human life and the progress of civilization are influenced by three distinct but closely interlocking types of cycles in addition to the more obvious cycles of the day and year.
>
> The most familiar of these is cycles of ordinary weather. No one doubts the existence of these, for everyone sees the effect of unusual

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* Italics supplied. This and the following quotations are from the *Review of Economic Statistics,* November, 1935, pp. 105–115.

> heat or cold, rain or drought, sunshine or fog. Variations in the growth of plants, including all kinds of crops, are directly dependent on such cycles, and are influenced by them far more than any other factor. Weather also influences reproduction and growth of animals, both directly and through plants and the food supply. The indirect effect of the weather on man, however, is for this very reason greater than upon animals and far greater than upon plants. Cycles of weather have been and still are among the chief stimulants to invention, thrift and foresight.
>
> The next great type of cycles is especially evident in animals. It shows itself primarily in physiological processes, especially reproduction. . . . The only known factor which shows the required periodicity and seems competent to produce the observed results is atmospheric ozone. . . . Thus the most tenable working hypothesis seems to be that, in addition to cycles of temperature and moisture, there are cycles of ozone which are especially associated with the reproduction of animals. Man also appears to be influenced, but not so much as animals.
>
> The third cyclic type is primarily human and psychological. At any rate it is only in human beings that we have as yet found clear signs of it. It displays itself in business and prices in a most interesting way. Similar rhythms are found in atmospheric electricity. The evidence is sufficient to warrant the working hypothesis that atmospheric electricity, due presumably to the sun, but perhaps also to the whole solar system, is a cyclic factor closely associated with psychological reactions.
>
> The three types of cycles, due supposedly to heat, ultra-violet radiation and electrical radiation, appear to be so intimately connected that it is often difficult to separate them. . . .*

These three types of cycles, as Huntington observes them, are associated with *solar* phenomena. Variations in heat received from the sun are primarily responsible for weather variations that act directly on plants. Variations in ultraviolet radiation create variations in ozone content of the earth's atmosphere, with a direct effect on biological processes in animals. Variations in radiated electricity seem directly to affect the psychological processes of man — or, as Huntington also suggests, " the nerves."

Edgar Lawrence Smith has suggested that such an electrical radiation may react directly on the blood, and affect its acid-alkaline balance.

Reproducing a pH curve showing 1938 changes in the ratio of acidity to alkalinity in the blood stream of numerous persons tested by Dr. William F. Petersen, of the University of Illinois, Smith compared it with the 1938 course of the stock market variations, found it closely similar. He then sought the doctor's opinion. Dr. Petersen, who is author of *The Patient and the Weather*, confirmed Smith's own impression:

> Offhand, I should say that the pH curve certainly coincided with your stock market variations for 1938. . . . In general, the population is apt to be depressed and blue when the pH is low, and buoyant and energetic and optimistic when the pH curve is higher. There are, of course, many exceptions, but in general I would say that this would be the effect. This quite coincides, as you will notice, with your stock market.*

The work of two Germans, Bernhard and Traute Düll, has produced some important data bearing on Huntington's hypothesis as to a relation between changes in atmospheric electricity on the psychological states of men. First, the Dülls showed synchronization between solar eruptions of incandescent gas and curves in the instrumental records of atmospheric electricity at Saint-Cyr in France and at Tunis in North Africa. Their work seems to have made it clear that *variability* in solar activity, more than the area and number of sunspots, is the solar factor we should consider in seeking to establish solar-terrestrial relationships; and that *variability* in the average potential gradient on earth, instead of its average intensity, is the factor that shows most promise of yielding a correlation.

Having established a relationship between solar activity and atmospheric electricity, the Dülls then plotted for three months the daily deaths in Copenhagen, Frankfurt am Main, and Zurich. The curves for the days when most deaths occurred from suicide, mental disorders, and diseases of the nerves, sensory organs, and nervous system, ran almost parallel with the curve for magnetic disturbance on these same days. A similar plotting of suicides in Denmark, Germany, and Switzerland showed an apparent close relationship between the course of the curve on 735 days when suicides were especially numerous, and a similar rise in the curve for calcium flocculi on the sun's surface.

Increases in the number of sunspots or in solar eruptions are ordinarily accompanied by increases in solar radiation. Solar radiation consists not only of heat waves and ultraviolet rays — which affect us as sunburn — but of many other forms of waves which do not register on our senses at all. Our increasing knowledge gives us ground to suspect that many of these unsensed waves affect us as vitally (perhaps even more vitally) as those we know about through our sense organs.

The earth circling through space is a target for wave lengths of enormous range. We know, for instance, that electromagnetic waves alone cover a range of at least 25 " octaves " — an octave here meaning the interval from one wave length to another ten times as great.

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* *Mainsprings of Civilization* (John Wiley & Sons, Inc.), pp. 526–527.

* *Tides in the Affairs of Men* (The Macmillan Company), p. 82.

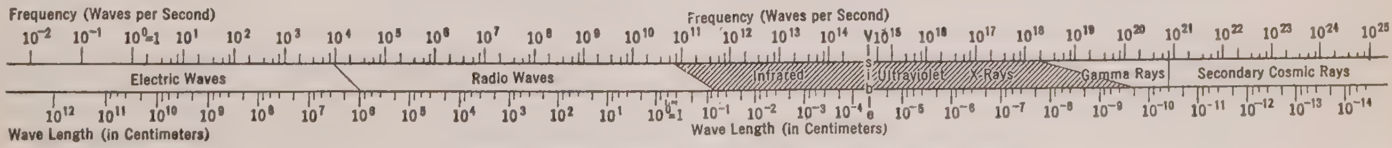

Fig. 11. Wave Spectrum (After Compton and Caldwell)

A Spectrum of Electromagnetic Waves with Lengths from 10^{12} to 10^{-14} Centimeters; that is, with Frequencies from 10^{-2} to 10^{25} Waves per Second

Some waves have a length of 5,000 miles or more — we use similar waves on high-tension power lines. Some have a length of only a trillionth part of a millimeter — these being the waves that help ionize the air at high levels, permitting it to reflect radio waves and so making radio communication possible.

Figure 11 is a chart which shows some of the characteristics of this enormous electro-magnetic wave band, and serves also to indicate how few of the radiations register on our senses. We have discovered the others only as we developed instruments which served — as a supplement to our five senses — to detect them. Visible light, it will be noted, occupies only about a single octave of the radiation.

Our social sciences have tended to forget, in the bravura of modern times, one fact which to many of the ancients was clear: Man is a child of the earth, and by that same token a part of it, and for this reason he must also be a child of the sun. If our modern research should find clear evidence that the rhythms of the sun dominate in man's life, as they dominate in many of the other phenomena our sciences study, only men too proud to remember their paternity should be surprised.

But before such a hypothesis can be more than a mere hint to guide the direction of our research we need a great many more data than we have yet amassed. Data we do possess would indicate we are on a track well worth following.

We already have good evidence that one of the major rhythms felt by our economic system — the $3\frac{1}{2}$-year rhythm — has a parallel in solar activity. It will be remembered that this rhythm runs from 40 to 42 months. T. E. Sterne, of the Harvard University Observatory, has determined that the solar constant, as measured by the Smithsonian Institution, fluctuates in a compound rhythm, one part of which averages almost exactly 40.8 months in length. The wave is quite clear. It will be further remembered, in this connection, that Huntington has also shown a 41-month rhythm in the variation of atmospheric electricity — the potential gradient — over a longer period of time than Sterne's study covers.

As for the other three rhythms to which the major portion of our study has been directed, the evidence as to closely corresponding rhythms in the sun is worth analyzing. Not all students have found satisfying parallels.

Here is a table compiled by H. H. Clayton, which shows the calculations made by various workers of certain major sunspot rhythms, in intervals of years: *

	Periods in Years								
A. Schuster	4.8	...	...	...	8.4	....	11.13	13.5	....
K. Stumpff	...	5.6	7.3	...	8.8	10.0	11.13	12.9	14.3
A. E. Douglass	...	...	...	...	8.5	10.0	11.4	13.5	14.3
D. Alter	...	...	7.6	8.1	8.7	10.0	11.37	....	14.0
H. H. Clayton	...	5.6	...	8.1	8.94	9.9	11.17	....	14.9

Clayton's 8.94-year period shown here might seem suggestive of our 9-year economic cycle, but no more. On the whole, there is nothing here to throw light on our four major economic rhythms.

Great efforts have been made to show that there is a business cycle corresponding to the obvious sunspot cycle of around 11 years. But evidence of a direct relationship between business and the 11-year sunspot rhythm seems open to some criticism. For, while a parallelism has been shown, for short spans, between the 11-year cycle and business activity (see the work of H. T. Stetson, and of Garcia-Mata and Shaffner), these spans are not long enough to give us conclusive evidence. On the contrary, we have better evidence that other rhythms are far more important in our economy. Certainly none of the periods listed by Clayton corresponds to the rhythms we have been noting in the economy.

C. N. Anderson, of the American Telephone and Telegraph Company, has originated a different technique in research on the same subject, with far more interesting results. Figure 12 shows his analysis of components of the sunspot cycle. Using sunspot data that goes back to 1749, he found a long-term cycle of 312 years, with a rhythm of 22.28 years as the chief component. In Fig. 12 * the component rhythms of the cycle are shown by lines which indicate — in their relative length — their relative importance as components. Their position on the scale indicates the length of each component rhythm in years.

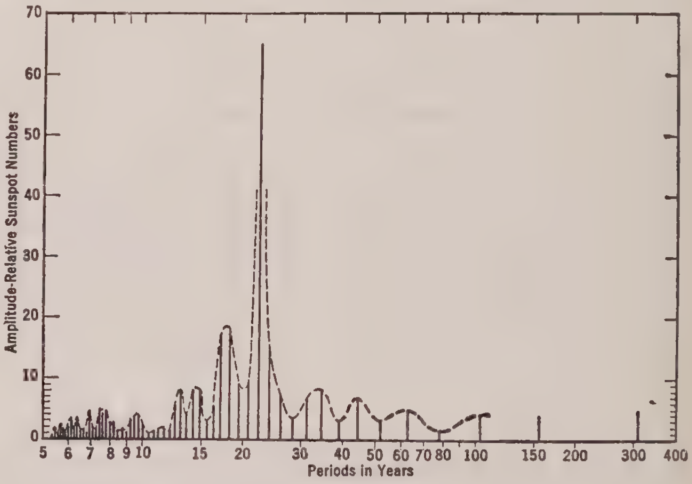

Fig. 12. Sunspot Cycles

Relative Importance of Various Components of a Harmonic Analysis of Sunspots, with alternate cycles reversed. Fundamental 312 years. (After C. N. Anderson.)

A list of some of the more important lengths follows:

Fundamental	312 years	9th Harmonic	34.6 years	17th Harmonic	18.35 years
2nd Harmonic	156 "	10th "	31.2 "	18th "	17.33 "
3rd "	104 "	11th "	28.40 "	19th "	16.42 "
4th "	78 "	12th "	26.00 "	20th "	15.60 "
5th "	62.4 "	13th "	24.00 "	21st "	14.85 "
6th "	52.0 "	14th "	22.28 "	22nd "	14.18 "
7th "	44.6 "	15th "	20.80 "	23rd "	13.56 "
8th "	39.0 "	16th "	19.50 "	24th "	13.00 "

In the beginning Anderson used an interesting discovery made by Hale. In alternate 11-year cycles in solar phenomena, most sunspots reverse their polarity. It would appear that alternate cycles may be considered negative, and that the true cycle is twice the approximate 11.13, amounting to something over 22 years. Adopting this hypothesis, and subjecting to harmonic analysis a 300-year

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* From "The Sun Spot Period," *Smithsonian Miscellaneous Collection,* Vol. 98, No. 2.

* Reproduced from the *Bell System Technical Journal,* April, 1939, p. 298.

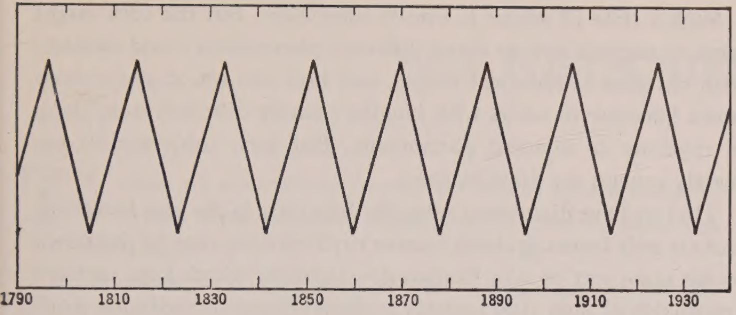

FIG. 13. SKELETONIZED REPRESENTATION OF THE 18⅓-YEAR RHYTHM IN SUNSPOT NUMBERS

Diagram of the 17th harmonic of C. N. Anderson's Harmonic Analysis of Sunspot Numbers with alternate cycles reversed. The diagram is correct for amplitude and dates, and approximately correct for average shape. (Compare with the 18⅓-year rhythm discussed in Chapter IX.)

series of sunspot numbers with alternate cycles reversed, Anderson found rhythms that closely correspond — both in time span and in timing — with our economic data. Inspection of this chart in Fig. 12 shows immediately that the 22.28-year rhythm is of dominant importance. This is very close to rhythms we find in many meteorological phenomena.

Next in importance in Anderson's chart are the two adjacent rhythms of 17.33 and 18.35 years. The rhythm at 18.35 years is an almost perfect match for our 18⅓-year economic rhythm that we see evidenced so clearly in real estate — and it reaches its crest at the same time. (See Fig. 13.)

The 17.3-year rhythm shows up in epidemics of disease, in cotton prices, and in a number of other economic series.

It will be noted that the component at 14.8 years also is very strong. Seemingly the same rhythm shows up in the purchasing power of beef cattle prices (see page 137), of pepper prices (see page 138), and in bond prices.

Clustered around the 9- to 10-year period the reader will note rhythms at 8.91, 9.17, 9.45, 9.8, and 10.1 years. This diagram does not mean — either at this point or elsewhere — that rhythms with exactly these periodicities have been isolated. It does indicate that either at or between these points there are waves of at least the importance indicated. The fact that five such waves show up in the 8.91- to 10.1-year period suggests that further research may disclose counterparts of the 9-year rhythms we have encountered in economic phenomena. As a suggestion of possibilities, see Fig. 14.

Anderson's data should also be examined to see if the wave indicated around 52 years may not — when isolated — correspond to the 54-year economic cycle already discussed. Some observers, like Gillette, have suggested that the 54 may be viewed as a multiple of the 9 or the 18. We may well view the use of such multiples with reserve, until we have more evidence warranting such an approach to the use of the data. They are interesting, but hardly conclusive.

A number of other research workers have made extensive computations on the solar rhythms, and have traced various other correspondences between solar periods and rhythms in terrestrial phenomena.* Unfortunately, the research is still in its infancy. In view of the great possibilities glimpsed in the short period of study described here, one would presuppose that many resources had immediately been put behind the work. On the contrary. To date the work has been conducted with extremely limited funds. This is one of the gaps in our knowledge that needs filling promptly. In particular, as Huntington has suggested, we need to analyze the solar cycles not only in terms of the *number* and *area* of sunspots, flocculi, etc., but in terms of the rate of change, or variability. When this has been done, it is to be hoped that both biologists and psychologists will extend the research to determine just how far solar rhythms are related to human rhythms — including those in economic life — and what the relationship may be.

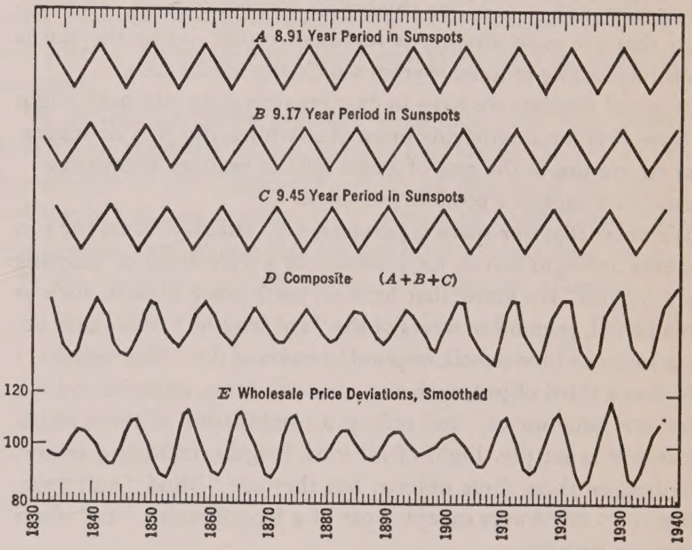

FIG. 14. OTHER SUNSPOT CYCLES AND PRICES

Skeletonized Representation, 1832–1939, of (A) the 8.91-year, (B) the 9.17-year and (C) the 9.45-year Components, as used by C. N. Anderson in his Harmonic Analysis of Sunspot Numbers. Alternate Cycles Reversed.

Also included are (D) the Combination of A, B and C, and (E) the 9-year Wave in Wholesale Prices, 1832–1939.

It will be noted that turning points in prices generally *precede* the corresponding turning points in the combined solar series. Prices are smoothed by a three 9-year section moving average. (For an explanation of the section moving average, see Appendix III.)

Tchijewski, a Russian, has conducted a series of studies which shortly before World War II were gaining wide attention in Europe, but have had small audience in English-speaking countries. It is his conclusion that increased electrical activity in the sun, especially around sunspot maxima, increases ionization of the air. He believes this in turn stimulates mankind both physiologically and psychologically, with effects that can be traced throughout all social relationships.

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* See H. W. Clough, *Monthly Weather Review*, April, 1933, U.S. Department of Agriculture, pp. 99–108.

Dr. Raymond Holder Wheeler, of the Psychology Department at the University of Kansas, has developed a theory of the effect of changes in heat radiation on society and civilization, which as a study is related to this same type of inquiry. His exhaustive accumulation of historical data tends, just as does Tchijewski's, to support the postulate that solar rhythms of many lengths and amplitudes are connected with human rhythms that show up regularly through history.

One important finding results from Anderson's studies. In a number of the solar rhythms, the peaks usually come at the time of, or after, the crest of the rhythm in economic affairs. This suggests that the solar rhythm is itself not causal — that the sun is itself responding to some rhythm which also affects men.

None of the data we have to date regarding the ultimate origin of these rhythms is satisfying proof of anything. But they do suggest that we are just at the gate of a new field of exciting knowledge.

And they suggest a possible postulate:

We know that our space is permeated by radiation from the sun — there are light waves, for instance, of a wide band of differing wave lengths. We know that here on earth some objects, such as a red pencil, respond to waves of the " red lengths "; that other objects, such as a blue pencil, respond to waves of the " blue lengths "; and that a third object, such as a woman's dress, responds to both " red and blue waves " and reflects a combination of these which we regard as purple. Light of all wave lengths, including yellow, is falling on these three objects; but they are " blind " and unresponsive to any waves except those of a length which " fit " their respective natures.

We also know that there are, in the universe, waves longer than light waves, with a longer time interval from crest to crest, which are used for radio transmission. Here, similarly, certain waves may be affecting one radio, whereas another radio, in the next room, may be totally unaffected by them, but is being affected by other waves of different frequencies.

Now, let us suppose that there are still longer waves in the universe — " Y " waves we may call them. Imagine some of the waves with peaks which come 3½ years apart, others with peaks 9 years apart, 18⅓ years apart, 54 years apart, and perhaps much farther spaced. It is not inconceivable that these longer waves could directly or indirectly affect the sun, the weather, animals, and human beings, and that just as a red pencil may respond to light waves of only one length, so a particular kind of organism might respond only to Y waves of one particular length.

Such a state of affairs is wholly imaginary. But the idea might serve to explain how so many different phenomena could oscillate with rhythms of identical length, and how one set of phenomena could fluctuate in waves with lengths entirely different from those of rhythms in adjacent phenomena. But such conjectures completely outrun the facts in hand.

That we have discovered solar rhythms only in the past few years, and are only learning about human rhythms now, may be put down to the same sort of slow human development which kept us from knowledge of such vital matters as electromagnetic radiation until the nineteenth century of our era.

There is, of course, an excuse. For these rhythms are extremely complex. How long, for instance, might it have taken men to discover the rhythm of the tides, if the earth — like Jupiter — had nine moons instead of one? Suppose, in addition, that our earth were so surrounded by fog we could not see the moons. How complex the tides would be, and how mysterious! We might even yet have failed to discover that the tidal sweeps of our oceans were gravitational rhythms united in a complex synthesis.

The work ahead of us stretches far and long. Fortunately that knowledge of ultimate cause, though it may be an ultimate goal, is not immediately vital to the conduct of our study, any more than to that of other sciences. As the great Eddington has declared: " In spite of popular opinions to the contrary, scientific investigation does not lead to the knowledge of the intrinsic nature of things. Whenever we state the properties of a body in terms of physical quantities, we are imparting knowledge of the response of various metrical indicators to its presence, *and nothing more.* To go further is the task of philosophy."

Whatever working hypothesis concerning the cause of human rhythms the reader may prefer to adopt for purposes of study — whether he looks more favorably on the theory of free or forced oscillations, or prefers some other one — he can still find the analysis of the rhythms full of reward. For, as Dr. Willford I. King, professor of economics at New York University, has said so well:

> If the oscillations in business are dominated by forces following some mathematical formula, whether that formula be one representing a composite of sine curves or otherwise, the pattern of business must to a considerable extent be repetitive in nature and hence predictable. For any curve, or combination of curves, represented by mathematical formulae, can be reproduced indefinitely into the future.*

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* *The Causes of Economic Fluctuations* (The Ronald Press), p. 244.

1954 POSTSCRIPT TO CHAPTER X

THE cause of cycles remains in the realm of conjecture. We do not know any more about causes than we knew ten years ago.

On the other hand, the work of the past ten years, as reported upon in *Cycles—A Monthly Report*, in the *Journal of Cycle Research*, and elsewhere, shows that the subject is much more complicated than was originally believed. A whole spectrum of wave lengths has opened up. It is probable that cycles exist with wave lengths that are within one percent of each other. However, no satisfactory or adequate law has been suggested to show the interrelationship of the various wave lengths.

Naturally, with so many different wave lengths, you will find at least a certain degree of correspondence with any astronomical cycles you might happen to pick for purposes of comparison. But here again, the known factors do not yet warrent any theory of interrelationship.

In the development of the science of astronomy, a basic prerequisite was the accumulation of an enormous mass of factual information. This was achieved by Tycho Brahe (1546—1601) and others. This mass of material, unglamorous in itself, provided the basis upon which Johann Kepler (1571—1630) was able to formulate his celebrated three laws of planetary movement.

The science of cycles probably needs many more Tycho Brahes before the stage can be set for its Keplers (although, if the hypothesis of Dr. Leonard W. Wing, as discussed in *Cycles —A Monthly Report* for May 1954, stands up under further investigation, one of our Keplers may have already been born).

In the meantime, all we can do is to keep on plugging.

E.R.D.

Mr. H. A. Musham
741 No. Rush St.
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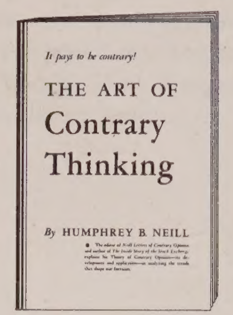

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